LIVERPOOL SCHOOL OF TROPICAL MEDICINE

REPORT OF THE MALARIA EXPEDITION TO NIGERIA

PART II

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LIVERPOOL VNIVERSITY PRESS

REPORT OF THE
MALARIA EXPEDITION TO NIGERIA

Part II. Filariasis

LIVERPOOL SCHOOL OF TROPICAL MEDICINE—MEMOIR IV

REPORT

OF THE

MALARIA EXPEDITION TO NIGERIA

OF THE

LIVERPOOL SCHOOL OF TROPICAL MEDICINE
AND MEDICAL PARASITOLOGY

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PART II. FILARIASIS

WITH ILLUSTRATIONS AND PLATES

PRICE 10/6 NETT

AT THE UNIVERSITY PRESS OF LIVERPOOL 1901

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No. 12. *September*, 1901. 500 *Copies printed*

DONALD FRASER, PRINTER TO THE UNIVERSITY PRESS OF LIVERPOOL

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PREFACE

The series of new blood filariae described in the following pages were found during the examination of a large number of West African birds of different species for parasites of the red blood corpuscles. The discovery of the blood filariae naturally led to a search for their parent forms: but time did not permit of any extensive investigations being made as to the nature of their intermediary hosts.

Opportunities also occurred for observations on human filariasis in West Africa, which combined with the work on avian filariasis, will, it is hoped, throw considerable light on this very interesting branch of parasitology.

The description of the parasites has involved a great amount of labour in the examination of the literature of the subject, and for this reason, and also because of the rapidly increasing importance of the subject, and of the desire for a comprehensive work, often expressed by investigators in tropical countries, it has been considered desirable to incorporate in this work STOSSICH's extensive bibliography, and also to introduce chapters on the Nematodes in general and the Filariae in particular, for the greater part of the matter of which we are indebted to the valuable works of SHIPLEY (*Worms*, etc., The Cambridge Natural History) and RAILLIET (*Zoologie médicale et agricole*).

The authors wish particularly to thank Mr. A. E. SHIPLEY for his useful advice and help; Mr. ROBINSON, who kindly undertook the identification of the birds of our collection; Dr. A. H. HANLEY for much valuable material; and our colleagues at University College for their assistance.

H. E. A.
J. E. D.
J. H. E.

September, 1901

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REPORT OF LIVERPOOL EXPEDITION TO NIGERIA

PART II

I. *FILARIASIS*

INTRODUCTION

THE NEMATHELMINTHES, the order to which the genus *Filaria* belongs, have the following characteristics :—they are worm-like in form, but non-segmented; that is, their bodies are not divided into segments, each resembling more or less exactly in outward appearance and internal structure the preceding and following segment. Many bear bristles or hooks, and exceptionally suckers. The body is elongated, thread-like, enclosed in a more or less thick cuticle. They have no closed vascular system nor special respiratory organs. They are almost all dioecious—the male and female reproductive organs being in different individuals. The young somewhat resemble the adults, but have no sexual organs ; the immature stages, termed *larvae*, are often free while the adults are parasitic or *vice versâ*, or inhabit a different host from the adult. Some of these Nemathelminthes spend their life within the bodies of their hosts, or are only parasitic during a portion ; a few have a free life in water or damp earth.

The Nemathelminthes comprise three sub-orders :—

1.—The Nematoda
2.—The Nematomorpha (Gordiidae)
3.—The Acanthocephala

The Nematoda have a complete digestive tube ; in the Nematomorpha it is atrophied in the adult, while in the adults of Acanthocephala it is absent altogether. In the sub-order Nematomorpha (Gordiidae) are two genera, *Gordius* and *Nectonema ;* the latter has only a single species, *Nectonema agile*, which is marine. The genus *Gordius*, which is entirely fresh water, has a large number of species. Worms of this genus pass through three stages, two larval and parasitic, the third, sexually mature, living in water. The first larval stage has been found in the larvae of *Sialis lutaria Ephemera*, *Tanypus*, *Corethra*, *Chironomus* ; the second is parasitic in the bodies of *Carabus hortensis*, *Procerus* (*Carabus*), *Coriaceus*, *Calathus fuscipes*, *Molops elatus*, several species of *Pterostichus*, and other beetles.

According to RAILLIET[1] cases have been recorded in which the adult forms of some species of this genus have been evacuated after the administration of an anthelmintic—in some of the cases troublesome symptoms occurred. The actual

1. Railliet, *Traité de Zoologie Medicale et Agricole.* Paris, 1895. P. 563.

species described as occurring thus, are :—*Gordius aquaticus*, *G. tolosanus*, *G. varius*, *G. chilensis*. Probably they gain access to the alimentary canal of man and animals through the medium of drinking water.

The Acanthacephala include, following SHIPLEY,[2] four families :—Neorhynchidae, Gigantorhynchidae, Echinorhynchidae, and Arhynchidae. The adult forms have no alimentary tract, and are provided with a retractable proboscis, armed with hooklets, arranged in longitudinal rows. The adult stage occurs in the alimentary canal of vertebrates, generally those which live in or near water; while the larvae are found in the bodies of certain invertebrates, generally small Crustacea[3], *e.g.*, *Gigantorhynchus gigas* inhabits the small intestine of the pig, wild boar, and occasionally man, while the larval host is believed to be some species of beetle (*Melolontha*, *Cetonia*, and *Lachnosterna*). *G. echinodiscus* inhabits the intestine of ant eaters; *G. spira* of the king vulture; *Echinorhynchus proteus* of fishes (gudgeon, trout, turbot, etc.); the larval stage in some Amphipod Crustacea, and some fresh water fishes (minnow, etc.). Other species of Echinorhynchus occur in the duck, dog, rabbit, some aquatic birds, and occasionally man.

The *Nematodes* present very great difficulties to the systematist in their classification. SCHNEIDER[4] divided them into three groups :—(i) the Polymyarii, in which numerous muscle cells are seen in a transverse section; (ii) the Meromyarii, in which only eight are seen, two in each quadrant; (iii) the Holomyarii, in which the muscles are either not divided or only divided by longitudinal lines. Other classifications have been based upon the life history, but in many cases this is only very imperfectly known. At present the arrangement of the muscles (Polymyarii, Meromyarii, Holomyarii), the arrangement of the lips and mouth parts, the character of the male tail, the number of papillae, and the number and size of spicules, are the features which are relied upon for classification. SHIPLEY[5] deems it advisable at present to abandon the larger groups, and to deal directly with families. Of these he quotes seven :—

I. Ascaridae.
II. Strongylidae.
III. Trichotrachelidae.
IV. Filariidae.
V. Mermithidae.
VI. Anguillulidiae.
VII. Enoplidae.

We have considered it advisable to state briefly here the characteristic features of each of these families, and to describe shortly those forms of each family which are interesting to the student of human parasitology.

2. Harmer and Shipley, *The Cambridge Natural History*, Vol. II, *Worms, Rotifers, and Polyzoa*. London, 1896. P. 182
3. Harmer and Shipley, *The Cambridge Natural History*, Vol. II, *Worms, Rotifers, and Polyzoa*. London, 1896. P. 174.
4. Schneider, *Monographie der Nematoden*. Berlin, 1866.
5. Harmer and Shipley, *The Cambridge Natural History*, Vol. II, *Worms*, etc. P. 138.

I. Ascaridae

Shipley[6] gives the following characteristics: 'Body rather stout. A dorsal and two ventro-lateral lips bearing papillae. Buccal cavity distinct, seldom provided with chitinous armature. The oesophagus has two dilatations. The tail of the male is ventrally curved, and usually there are two horny spicules.' The females have a double ovary, and are generally oviparous.

Genera: *Ascaris*, *Heterakis*, *Oxyuris*, *Nematoxys*, *Oxysoma*, and others.

Genus *Ascaris*. These are polymyarian and have three lips, generally bearing teeth. The males have two equal spicules and a number of pre- and post-anal papillae, by the latter of which the best specific characters are furnished. The vulva is situated about the middle of the body. The ova are globular or ellipsoidal. They inhabit the intestines of their respective hosts. The species are very numerous.

The *life history* has not been completely worked out. Infection experiments by feeding directly with material containing ova have always failed. It is probable that the larval stage is passed in some intermediary host, and Von Linstow has lately suggested the millipede *(Julus guttulatus)* in the case of *Ascaris lumbricoides*.

Genus *Heterakis*. Also polymyarian, distinguished from the Ascarides by the presence of a ventral sucker and two often unequal spicules in the male. The male tail has also two series of papillae symmetrically placed, and often two lateral cuticular expansions representing a bursa. Almost all are oviparous. They live in the intestines of vertebrates, particularly of birds. There are several species, found in the fowl, turkey, duck, pigeon, pheasant, bustard, peacock, etc.

The *life history* seems to be simple, at least in the case of *H. taché*, the embryo developes from the ovum in moist media in about seventeen days, and when these ova containing embryos are given to pigeons, adult *Heterakis* are produced in three weeks.

Genus *Oxyuris*. Meromyarian, have three slightly-projecting lips. Oesophagus long with distinct bulb. Males are small and scarce, have a single spicule; two pairs of pre-anal papillae. Females have a long capillary tail, two ovaries, vulva opens in anterior portion of body. Ova are oblong and symmetrical, and often contain an embryo before parturition. Many species inhabit the intestines of man, horse, hare, rabbit, and iguana; and others the rectum of insects, cockroach, water beetle, etc.

The *life history* is simple—the ova, containing developed embryos are taken directly into the alimentary tract, and develop into adult worms.

Genus *Nematoxys*. Meromyarian has very complete arrangement of muscles and forms a transition to the polymyarian type.[7] The whole body of both sexes is

6. Harmer and Shipley, *The Cambridge Natural History*. Vol. II. P. 138.
7. Harmer and Shipley, *The Cambridge Natural History*. Vol. II. P. 142.

covered with numerous irregularly scattered papillae. There are but few species—found in snakes, amphibia, and eels.

Genus *Oxysoma* has but three species—found in the intestines of opossums, frogs, and turtles.

II. Strongylidae

Long cylindrical body, seldom filiform or capillary. Mouth surrounded with papillae, probably always six in number; often has an armature of teeth or spines. No distinct oesophageal bulb. The male orifice at the tail end is surrounded by a bell-shaped bursa, with one or two spicules. The female has one or two ovaries: the vulva is sometimes anterior, sometimes posterior to the middle of the body, sometimes near the anus. Ova are already segmented or contain embryos on leaving vagina.

Genera: *Eustrongylus*, *Strongylus*, *Dochmius*, *Sclerostomum*, *Cucullanus*, *Syngamus*, *Pseudalius*, *Ollulanus*, *Oesophagostoma*, and others.

Genus *Eustrongylus*. Cylindrical. Mouth has no lips, but is surrounded by papillae. Male has a filiform spicule; female a single ovary, vulva in anterior part of body.

Only two species known: *E. Gigas*, which inhabits the kidney capsules of carnivorous animals, especially of those which eat fish—dogs, seals, etc., and occasionally man, horse, and deer; and *E. tubifex*, found in aquatic birds—ducks, grebes, divers, etc.

Life history: In case of *E. gigas* the eggs are eaten by fish, the larval stage being passed in the peritoneal cavity of some fishes.

Genus *Strongylus*. Body slender; anterior end sometimes winged. Mouth often indistinctly lipped, has six small papillae. Males have a conspicuous genital bursa, strengthened by variously arranged ridges, which are of specific value. Female posterior end pointed, vulva almost always in posterior half of body.

There are numerous species found in mammals, birds, and reptiles. Some inhabit the intestine; others form aneurisms in the large blood vessels, particularly of horses; others live in the tracheae and lungs of sheep and cattle. They have been found in respiratory tract of the sheep, goat, ox, calf, pig, horse, cat, rabbit, hare, deer, buck, gazelle, ass, dromedary, etc.; in alimentary tract of sheep, goat, chamois, ox, deer, pig, horse, rabbit, etc.; in circulatory system of dog and horse.

Life history: (1) Those of the digestive tract have a rhabditiform embryo[8] provided with an oesophageal bulb, with three chitinous teeth. This embryo lives and grows on the organic matter in mud, and undergo a direct development. (2) Those of the respiratory tract produce larvae with an indistinct oesophageal bulb with no teeth; they do not grow in mud. Their development has not been followed, possibly they have an intermediary host.

8. Railliet, *Traité de Zoologie Medicale et Agricole.* Paris, 1895. P. 424.

Genus *Dochmius*. Anterior end turned towards dorsum. Mouth oval, limited by a chitinous border, followed by a chitinous buccal capsule, the dorsal wall of which is shorter than the ventral, and is supported by a conical rib, the point of which may project into the cavity. At the bottom of the capsule on the ventral wall are two teeth; towards the free edge the ventral wall also bears two other teeth, which are hooked at their extremities. The dorsal free edge is also sometimes similarly toothed. There are several species inhabiting the intestinal canal of man (*D. or Ankylostoma duodenale*), anthropoid apes, dogs, cats, sheep, and goats, wolf, fox, etc.

Life history: According to RAILLIET[9] and others, the embryos which hatch out, from the already segmented ova a few hours after leaving the intestine, under favourable conditions and after several moults, reach a stage in which they again, on gaining access to the alimentary canal, develop into adult ankylostomes. He mentions that LEICHTENSTERN has asserted that some larvae become transformed into sexually mature rhabditiform adults, which again produce larvae. GILES[10] also reports having traced the life history of the parasite through a sexually mature rhabditiform stage, the larvae of which become adult ankylostomes in the intestine of man.*

Genus *Sclerostomum*. Truncate anterior extremity, straight or slightly curved towards the ventral surface. Mouth circular, open, followed by a chitinous buccal cavity furnished along its edges with numerous teeth, disposed in one or several series. Male has two spicules and a generally tri-lobed caudal bursa. Vulva of female opens in posterior part of the body.

Several species have been found in the intestinal canal of the horse, mule, sheep, goat, deer, roe, antelope, etc.

Life history: RAILLIET[11] describes the following in the case of *S. equinum:* the eggs, passed with faeces, develop in water into embryos, which are taken up again probably in drinking water. They probably pass from the intestine into the circulatory system, and after a sojourn there return to the mucous membrane of the caecum, where they remain until a definite stage is reached, whereupon they pass into the intestine and pair. GILES,[12] however, in the case of *S. tetracanthum*, says that rhabditiform adults are produced as in the case of *Dochmius duodenale*.

Genus *Cucullanus*. Exists in the adult form in the intestines of fishes and reptiles. One species *(C. elegans)* lives in fresh water fish, *e.g.*, perch; while the young inhabit the body cavity of the crustacean *Cyclops*.

Genus *Syngamus*. Head end thickened. Mouth large. Chitinous buccal capsule. Males small; two spicules. Females have double ovary; vulva situated in anterior part of body; the male is generally permanently attached to the female, its genital bursa being closely adherent to the vaginal opening.

9. Railliet *Traité de Zoologie Medicale et Agricole*. Paris, 1895. P. 467.
10. Giles *Report on Kala-azar and Beri-beri*. Shillong, 1890.
* The recent researches of one of us (Annett) tend to confirm the truth of these investigations.
11. Railliet, *Traité de Zoologie Medicale et Agricole*. Paris, 1895. P. 459.
12. Giles, *Some observations on the Life History of Sclerostomum tetracanthum: Scientific Memoirs by Medical Officers of the Army of India*. Part VII. Calcutta, 1892.

The parasites inhabit the tracheae and bronchi of birds and mammals, fowl, pheasant, turkey, peacock, partridge, magpie, crow, duck, goose, etc.

Life History: The ova escape from the body with fully formed embryos in them, by the decay or rupture of the parent. They hatch in damp earth or water in from one to six weeks, and on being swallowed develop into adults which produce eggs in less than three weeks.

Genus *Ollulanus*. The name is derived from the characteristic appearance of the chitinous buccal capsule, which is urn shaped. The male has two short spicules; the female a single ovary.

One species only is known, *O. tricuspis*, found in the intestine, bronchi, and other parts of the cat. The larvae become encysted in the muscles of the mouse.

Genus *Oesophagostoma*. Small circular mouth has a chitinous ring around which the cuticle is raised into a transparent pad on which are six sharp papillae. The pad is separated from the body by a constriction behind which the integument forms an ovoid swelling well limited posteriorly, at the level of a transverse cleft which occupies the whole breadth of the inferior surface. A few species are known which inhabit the intestine of the ox, horse, chamois, sheep, etc.

Life History: The adults are free in the intestine, the larvae live in small tumours in the mucous membrane.

III. Trichotrachelidae

This family is characterised by the anterior end of the body being long and whiplike, the posterior somewhat swollen. The mouth has no papillae; there is no oesophageal bulb. Males may have no spicule, or more often a single spicule surrounded by a sheath. The females have a single ovary; the vulva is situated at the beginning of the thicker portion. Some are ovoviviparous, others oviparous. Their eggs have two characteristic poles.

Genera: *Trichocephalus*, *Trichosoma*, *Trichina*, and others.

Genus: *Trichocephalus*. The anterior and posterior parts well marked. The ventral surface shews anterior by a broad longitudinal band formed by a number of punctiform projections. The male tail is twisted spirally, with its concavity corresponding to the dorsal surface. The female has a single ovary.

Several species are known, inhabiting the intestine of man (*T. dispar*), monkeys, lemurs, swine, hog, peccary, dog, cat, sheep, deer, ox, etc.

The *life history* is simple; there is no intermediary host.

Genus: *Trichosoma*. The posterior part containing the intestine and generative organs, is but very little swollen. The posterior end of the male has no papillae, but bears a rudiment of a bursa.

Parasites of birds and mammals. In mammals, different species live in the bladder of the fox and wolf, and of the cat, and in the trachea of the fox and martin. In some species two, three, or four males live within the uterus of the female.

Genus *Trichina*. Small capillary worm, slightly swollen posteriorly. Male has two conical appendages posteriorly forming a sort of copulatory bursa. There is no spicule. Female is viviparous. Vulva situated in anterior fifth of the body.

A single species *T. spiralis* only known.

Life history. The adults, male and female, live in the intestine of man and other mammals. The female produces very numerous eggs which give rise to embryos in the body of the uterus. These embryos bore through the intestinal wall of their hosts, and make their way all over the body, coming to rest most usually in the muscles. Here they generally pierce the sarcolemma and become encysted inside the muscle fibre. The larvae may here remain dormant for many years, and undergo fatty or calcareous degeneration. When trichinised meat is eaten, unless thoroughly cooked, the cysts are dissolved and larvae set free, and become sexually mature in three or four days ; again producing ova and embryos which bore through the intestinal wall.

IV. Filariidae

Long filiform worms ; mouth with two lips or without lips—often have papillae, and sometimes a buccal capsule. Males have a tail generally incurved, have one or two unequal spicules, four pairs of pre-anal papillae, and sometimes an unpaired one as well. Females have double ovary. Vulva is situated towards the anterior part of the body. Many are ovoviviparous.

Genera : *Filaria*, *Ichthyonema*, *Hystrichus*, *Spiroptera*, *Disparagus*, and others.

Genus *Filaria*. See next chapter.

Genus *Ichthyonema* is confined to fishes. Male is very minute, and the female partly degenerate. No anus, no external generative organs. Uterus fills the entire body cavity.

Genus *Hystrichis*. The anterior part of the body is armed with spines. Male has a bell-shaped bursa, and very long spicule. Vulva is near the anus.

The parasite lives between the walls of the oesophagus and gizzard of some birds—palmipeds (duck, swan).

Genus *Spiroptera*. These can only be distinguished from the *Filariae* by two features—the body is generally shorter and thicker, and the vulva is ordinarily nearer the mouth. Their specific name is taken from the tail of the males, which is rolled into a spiral and furnished with lateral membranous expansions.

Several species are described generally met with in tumours of the oesophagus, stomach and intestines of horses, asses, mules, pigs, dog, wolf, etc. *S. reticulata* has been found in the cervical ligament, in periarterial tissue, between muscles and tendons, and in other positions in the horse.

Life history is unknown—an insect is supposed to act as an intermediary host.

Genus *Dispharagus*. These have the oesophagus divided into an anterior straight tubular portion, and a long thick muscular posterior portion with a bulb. Male tail extremity is more or less coiled, and has lateral expansions : four pre-anal papillae on each side, two unequal spicules. Female has a simple ovary, and is oviparous. The several species occur in the oesophagus and stomach of some birds.

V. Mermithidae

Mouth has six papillae. There is no anus. Males have two spicules and three rows of numerous papillae. Body of female reduced to a simple sac, crowded with ova.

Genera : *Mermis*, *Bradynema*, *Atractonema*, *Allantonema*, *Sphaerularia*, etc.

These are parasitic in some stage on insects, *e.g.*, the sexually mature forms of genus *Mermis* live in damp earth, while the larval stage find their way into grasshoppers, caterpillars, etc. The adult stage of *Bradynema* live in the body of small beetles, then reach the intestine, and eventually earth, where the females die, and the males, having developed spermatozoa in the larvae stage, now develop ova (protandrous hermaphroditism). The *Allantonema* have a somewhat similar history, as have also, *Atractonema* and *Sphaerularia*. The two last have the peculiar feature that at the time of sexual maturity a swelling—a prolapsus of the uterus and vagina—develops posteriorly and grows until it far exceeds the size of the worm. *Sphaerularia* are parasitic in the body cavity of many bees (Bombyx).

VI. Anguillulidae

These are for the most part free living and small. Oesophagus has two bulbs, the posterior without teeth. Buccal cavity contains a small spine. Males have sometimes a bursa with no papillae ; two equal spiculae. Females have a double ovary, and vulva in posterior half of body ; often ovoviviparous, but the number of embryos is small.

Genera : *Diplogaster*, *Mononchus*, *Rhabditis*, *Tylenchus*, *Anguillula*, *Heterodera*, etc.

Many species of this family live in humus or decaying matter, others are parasitic in plants ; some live in organic matter, and some few are parasitic in animals.

Tylenchus, *Aphelenchus*, and *Heterodera* infect plants and give rise to 'sickness' among clover, rye, oats, onions, beet, etc.

Genus *Rhabditis*. Oesophagus has two bulbs, posterior, and sometimes with teeth. Buccal cavity no teeth nor spines. Males may have a caudal bursa ; often has six to ten papillae on bursa or in middle line, two short spicules with an accessory piece. Some species are hermaphrodite.

Some species live in moist earth, others are described as causing a disease resembling typhoid, and larvae of species have been formed in the papules of some skin eruptions in man and dogs.

Genus *Anguillula*. Oesophagus has two bulbs, posterior has no teeth. Male is provided with a bursa with no papillae. The uterus is asymmetrical.

Numerous species are parasitic on plants, wheat, etc. *Anguillula aceti* is found in vinegar and paste. Others present two mature generations which succeed each other, (1) a free form, dioecious, resembling Rhabditis, and (2) a hermaphroditic form which is parasitic.

OERLEY places these in a new family, *Angiostomides* with three genera—*Angiostoma*, *Strongyloides* and *Allantonema*.

Anguillula intestinale (Strongyloides intestinale, Anguillula stercoralis) is parasitic in the intestine of man, giving rise to some forms of diarrhoea and dysentery (Cochin China), and produces ova which give rise to rhabditiform larvae, which are passed with the faeces. In the soil these become sexually mature, pair and produce larvae, which eventually reach the digestive tube to become *Anguillulae intestinale*.

VII. ENOPHIDAE

These are free living, small, usually marine; devoid of a second oesophageal bulb. Eyes and mouth armature often present. Fine hairs and bristles surround the mouth.

Genera: *Enoplus*, *Dorylaimus*, *Enchelidium*, etc. Some species are parasitic on plants, others on the sea urchin, and other animals.

II. THE *FILARIAE*

The genus *Filaria* is a very large one. It appears to be confined to vertebrates, usually living in the tissues of the body and not in the intestines. The worms are remarkable for their long slender bodies, which are almost of the same breadth throughout the whole length. The anterior extremity is rounded, and often has no lips. The males, which are markedly smaller than the females, have an incurved or spiral tail sometimes furnished with lateral expansions; more often they possess four pre-anal, and a variable number of post-anal papillae; the spicules vary considerably in size and appearance. In the females the vulva opens more or less near the mouth.

Filaria which are Parasites of Man

Filaria bancroftii
Filaria diurna
Filaria perstans
Filaria ozzardi
Filaria magalhesi
Filaria demarquaii
Filaria loa

} These will be described in a subsequent chapter.

Filaria medinensis

Guinea worm: The adult female is a white or yellowish worm, averaging about sixty centimetres long, though specimens reaching four metres in length have been described. Its breadth, which is uniform, is from 0·5 to 1·7 mm. The anterior extremity, which tapers slightly, is truncated, and presents a rugous cuticular thickening in the centre of which is the triangular buccal orifice. The thickening bears two large papillae, one dorsal and one ventral, and six small papillae. The body shows faint transverse striation. The cuticle is thick. The musculature is polymyarian. The tail incurved towards the ventral surface in the matured females, terminates in a sharply bent hook about 1 mm. in length. The alimentary canal consists of a fine tube running from the mouth to near the tail, but not opening externally in the gravid female, though an anal orifice exists in the young parasite. In the mature worm the uterus crowded with embryos fills the whole body cavity—vulval opening and vagina being obliterated. The embryos, usually lying curved on themselves *in utero*, measure 15 to 25 μ long by 0·50-0·70 μ wide. They are slightly flattened, transversely striated, and provided with a finely tapering tail which measures about two-fifths of their whole length. They have a rudiment of an

alimentary canal, and bear two small lateral sack-like structures at the base of the tail. They swim actively and may live for days in muddy water and damp soil. They are said by some authors to escape only by rupture of the adult worm, but according to MANSON[1] they are emitted by a prolapsus of the uterus through the mouth. The mature worm drills a hole in the derma. Over this the epidermis forms a bulla, which ruptures in a few days, disclosing a small superficial ulcer with a hole at its centre, under which lies the head of the worm. On the application of water to the ulcer, a minute quantity of whitish fluid is extruded, seen on microscopical examination to be swarming with embryos; or a little tube, the prolapsed uterus itself, is sometimes seen protruding. In about a fortnight the whole uterine contents are emptied. It is usually asserted that the female alone is known, and that it is uncertain whether it is hermaphrodite or whether both sexes are present in the *Cyclops*. CHARLES[2] has described a specimen found in the mesentery of a human subject from an orifice in the middle of the body of which he drew out a much smaller specimen, which may have been the male.

Life history. The young embryos in water attack a fresh-water *Cyclops* and penetrate through the interarticular membrane between the abdominal plates into the body cavity. Here the intestine of the parasite further develops, and on the eleventh day they moult and exhibit a very changed appearance, being shorter (0·5 mm.) and non-striated. In four weeks they measure 1 mm. in length. They are thought to reach man again through the medium of drinking water containing infected *Cyclops*: the parasite being able to pierce the tissues to reach its usual site in the legs. CHAPOTIN and others claim that the embryos can enter the body through the skin. PLEHN[3] reports to have fed two monkeys on bananas covered with embryos, and that one of them subsequently developed a painful tumour of the thigh and died after eight and a half months. The tumour contained a worm in all respects identical with *F. medinensis*, though only 4·0 cm. long.

Filaria lentis. Diesing

Syn. *F. oculi humani*, VON NORDMANN. Under this title are included nematodes, found on several occasions in the eye of man. Those described have varied considerably in length, 1·72 to 12·6 mm. RAILLIET[4] considers that they represent worms of different species which have gained access to the wrong host, or such as have been arrested in their development. Specimens have been described by VON NORDMANN, GESCHEIDT, and SCHÖLER.

Filaria inermis. Grassi

Syn. *F. palpebralis*, PACE, nec WILSON; *F. peritonei hominus*, BATES; *F. conjunctivae*, ADDARIO. The female only is known. It measures about 160 mm. long

1. Manson, *Tropical Diseases*. 1900 p. 554.
2. Charles, a Contribution on the Life History of the male *Filaria Medinensis*, founded on the examination of specimens removed from the abdominal cavity of man. *Scientific Memoirs, by Medical Officers of the Army of India*. Part vii. Calcutta, 1898.
3. Plehn, *Die Kameru-Kuste*, etc. Berlin, 1898. p. 295
4. Railliet, *Traité de Zoologie Medicale et Agricole*. Paris, 1895. p. 529.

by 0·475 mm. broad. It is of whitish or brownish colour, somewhat flattened, threadlike, and tapers slightly towards both extremities, but more especially posteriorly. The extremity of the tail is incurved. Cuticle is transversely and longitudinally striated, except at the cephalic end; musculature polymyarian. The mouth is very small, unarmed, and terminal; oesophagus is short (620 μ), widens somewhat at hinder end. The anal aperture is 300 μ from the tip of the tail, the vulva 50 to 104 μ from the mouth. The eggs hatch out in the uterus; the free embryos measure 350 μ by 5·5 μ, and taper slightly in front, sharply pointed posteriorly. A peculiar formation, probably of glandular nature, occurs at the point of the tail where the cuticle is thin: on each side of the thin portion is a break, with a corresponding canal which resembles the duct of a gland. In some examples there is a third one between the other two, but its outer opening was not made out.

Life history unknown. The adults have been found in man, the horse, and donkey. In man they have been found three times in the eye: once encysted in the gastro-splenic omentum, and once encysted in the ocular conjunctiva. *Filaria lentis* (DIESING) may be a young form of this worm.

Filaria volvulus. Leuchart

The description of the male and female of this worm is given by PROUT.[1] The female is 40·4 cm. long and the body 0·34 mm. wide, which gradually tapers to the head end which is 0·04 mm. across, and to the tail, where the diameter is 0·0084 mm. The cuticle is striated, the tail end slightly curved. Anal orifice was not made out. Alimentary canal simple. The double uterus was observed to commence at a distance of 4·35 cm. from the tail end in a sacculated extremity. The ova, containing coiled up embryos, measure 0·032 by 0·034 mm. Embryos are 0·18 to 0·2 mm. long and 0·001 broad.

The male is smaller and thinner than the female, being on an average 3.14 cm. long, and 0·44 mm. broad. The worm is white and flattened somewhat, has a striated cuticle, and is uniformly tapered towards each end. The diameter of the head is 0·044 mm., and of the tail posterior to the anal orifice 0·028 mm. The head is rounded; tail markedly incurved. The alimentary canal is simple. The anal orifice is at a distance of 0·049 mm. from the caudal extremity. The extreme end of the tail on the concave side is flattened, and here four papillae were made out. The anal orifice itself seems to have two lateral, one post- and one pre-anal papillae on each side. Two unequal spicules—one protruding was slightly clubbed at the extremity, and trumpet shaped at its inner end; the other commencing just within the orifice was much longer than the first, and of much the same shape, but narrower at the point. A narrow, central canal was observed in the former which has a minute opening at its free end.

1. Prout, *British Medical Journal*, January 26, 1901, p. 209.

Life history unknown. The adults occur in pairs in subcutaneous tumours, the purulent contents of which swarm with embryos. These are 0·25 mm. long, by 0·005 mm. broad, have a rounded head, sometimes a double tip. Their tails are sharp and granular. They have no sheath. In stained specimens a V-shaped spot can be made out at the junction of the anterior fifth with the posterior four-fifths.

Filaria labialis. Pane

The female only is known. It is about 40 mm. long, slender, tapering at each end, but slightly swollen at the extreme posterior end. The mouth is surrounded by four papillae. The anus is at 0·5 mm. distance from the posterior end, while the vulva opens at 2·5 mm. more anteriorly. The uterus is double.

Life history unknown. A single specimen only has been seen in a small pustule on the inner side of the upper lip.

Filaria hominis oris. Leidy

Length 140 cm., breadth 0·16 mm. A filiform, opaque white worm, with a simple round mouth, and blunt tail furnished with a short hook 50 μ in length and 12 μ across at the base.

Life history unknown. A single specimen has been found in the mouth of a child. It is thought by LEIDY and LEUCHART to be an immature *F. medinensis*.

Filaria lymphatica. Treutler

Syn. *Haemularia lymphatica*, TREUTLER; *F. hominus bronchialis*, RUDOLPHI. Length, 26 mm.; brownish in colour, speckled with white, almost transparent posteriorly. Body filiform, a little compressed laterally.

Life history unknown. Found in hypertrophied lymphatic glands. DIESING and WEINLAND regard it as identical with *Strongylus longevaginatus* (*paradoxus*). RAILLIET suggests it as a male *F. inermis*.

Filaria restiformis. Leidy

A single specimen only found, passed *per urethram*. Length, 65 cm.; breadth, 1·5 mm. Long, uniformly cylindrical body. Cuticle smooth, no transverse striation; head end tapering somewhat, rounded, no appendages. Caudal end incurved, no appendages. No apparent anal or genital aperture. RAILLIET considers this a pseudo-parasite.

SOME FILARIAE WHICH ARE PARASITES OF ANIMALS

Filaria equina. Abildgaard

Syn. *Gordius equinus*, ABILDGAARD; *F. equi*, GMELIN; *F. papillosa*, RUDOLPHI; *F. equina*, BLANCHARD.

A whitish filiform worm tapering towards the extremities especially posteriorly. Cuticle finely striated transversely. Mouth small, round, provided with a chitinous ring, the edge of which has laterally two crescentic lips, and at a point corresponding

to the dorsal and ventral median lines, a simple or indented papilla ; behind the ring are four submedian papilliform chitinous spicules.

The male is 6-8 cm. long, has a spiral tail, with four pre- and four post-anal papillae, and two unequal spicules.

The female is 9·12 cm. long, has a slightly spiral tale terminating in a rounded button, in front of which are two lateral conical protuberances. The worm is viviparous ; embryos measure 280 μ by 7 μ wide.

The embryos have been observed in the blood of animals found afterwards to contain the adult forms. They are one-seventh mm. in length, and one to three occurred in each drop of blood. They resemble the embryos of *Filaria sanquinis hominis*, but are much smaller.

Life history is unknown, but it is surmised that development takes place in the body of an insect host. The adults have been found in the peritoneal cavity, tunica vaginalis, fallopian tube, pleural cavity, between the dura and pia-mater, in the aqueous humour, in the intestine, and in the liver of horses, donkeys, and mules.

Filaria labiato-papillosa. Alessandrini

Syn. *F. cervina*, DUJARDIN ; *F. terebra*, DIESING. This species resembles the preceding in its appearance and dimensions. Mouth is oblong dorsoventrally, surrounded with a chitinous ring, the edge of which supports four curved projections. On the median, dorsal, and central line, the chitinous ring forms a papilliform spine, markedly double in the female. Behind the mouth are four small sub-median depressions, from each of which a tactile papilla arises. The male is 6-8 cm. long ; tail is closely spiral ; has three pre-anal, one ad-anal, and five post-anal papillae on each side, and behind these a conical projection. The female is 6-12 cm. long ; has a spiral tail, terminating in a number of small blunt points which arise from two lateral conical protuberances. The worm is viviparous ; embryos 140 to 230 μ long.

Life history is unknown. The adults have been found in the peritoneal cavity of cattle and deer.

Filaria haemorrhagica. Railliet

Syn. F. multipapillosa, CONDAMINE and DROUILLY ; *F. multipapilla*, MOLIN. White cylindrical body, slightly tapering at the extremities, more so behind than in front. Anterior extremity has a retractile cone. The integument is transversely striated. The striations near the anterior extremity become broken, and form elliptical or circular depressions, and a large number of papilliform projections. The mouth is simple, circular.

The male is about 28 mm. long, 0·26 broad ; posterior extremity is rounded, there are two unequal spicules, one 680-750 μ long, the other 130-140 μ.

The female has a length of 42-70 mm., and breadth 0·42-0·44 mm. ; caudal end rounded : the vulva is near the mouth. The ripe eggs are from 52-58 μ long, 24 to 33 μ wide, and contain an embryo.

The free embryos measure 220-230 μ long by 9-11 μ wide.

The *life history* is unknown. The male and female live together in the connective tissues of the horse and donkey giving rise to hemispherical protuberances about the size of a nut, beneath the skin. These quickly burst and allow blood to escape, after which they subside and appear again in twenty-four to forty-eight hours in other places. Tracts of the worm can be seen in many tissues post-mortem. It is surmised that the embryos are taken up by some insect or crustacean.

Filaria immitis. Leidy

Syn. *F. canis cordis*, LEIDY; *F. papillosa, haematica canis domestici*, GRUBY and DELAFOND.

Body white, filiform, a little tapering at each extremity especially posteriorly. Anterior extremity rounded. Mouth terminal, small, simple, surrounded by six small indistinct papillae. Anus near the end of tail.

The male 12 to 18 cm. long, 0·7 to 0·9 mm. broad, with spirally wormed tail bearing two small lateral ridges supported by papillae, four of which are larger than the others—there are three pre- and one post-anal papillae, MANSON[1] however describes the arrangement of papillae differently. Two unequal spicules.

The female is 25-30 cm. long, 1 to 1·3 mm. broad. The tail is short, blunt and curved; vulva is at a distance of about 7 mm. from the mouth. The ova hatch within the uterus: the free embryos measure 285 to 295 μ by 5 μ; their anterior extremities are slightly tapered and end bluntly, the posterior tapers gradually to a fine point. The embryos occur in large numbers in the blood of the infected animal. MANSON observed a certain degree of periodicity, the embryos being most numerous in the peripheral blood at night, not disappearing entirely however during the day.

Life history. The adult parasites are found chiefly in the right ventricle of the heart of the dog, fox, and wolf.

The development of the embryos has been the subject of many investigations. BANCROFT affirmed that he found the embryos in the intestine of *Trichodectes* which had sucked the blood of infected dogs, and supposed these insects to play the part of intermediary host. SONSINO confirmed this, but recognized later that *Trichodectes canis* does not suck blood and that *Haematopinus pilifer* was meant. GRASSI and SONSINO found larvae of Nematodes in the intestine and body cavity of dog fleas, and concluded they were dealing with the embryos of either *Spiroptera sanguinolenta* or of *Filaria immitis*. Subsequently it was found that Spiroptera do not give rise to haematozoal embryos, and it was inferred that dog fleas were the intermediary hosts. Later GRASSI conclusively proved that neither *Pulex serraticeps*, *Haematopinus*, nor ticks (*Rhipicephalus siculus*, KOCH) served as the hosts for *F. immitis*. In the previous

1. Manson, *Medical Times and Gazette*, 1877. Vol. II. page 513. etc.

investigations, he claimed that SONSINO was led astray by the coincidence that *F. recondita* was present in the dogs he examined, the embryos of which were mistaken for those of *F. immitis*. GRASSI then thought the intermediary host to be a crustacean or mollusc.

However in 1900 he[1] describes the development of these embryos inside the mosquito. 'The embryos sucked up by *Anopheles* migrate into the malpighian tubes, where they continue their development behaving more or less like the other blood filariae already known. The larvae, arrived at maximum development, abandon the tubes and enter the general body cavity leaving behind the old cuticle: there they progress towards the head and collect there rapidly in the prolongation of the general body cavity within the labium (called also the inferior labium), occasionally in the palpae.' In their experiments these authors seem to have allowed a period of thirteen or fourteen days for the complete development of the embryos in *Anopheles*. They do not appear, however, as far as we have been able to ascertain to have carried out the infection of healthy dogs by the bites of infected *Anopheles*. One experiment is described, undertaken on July 19, 1900, in which a healthy dog was injected subcutaneously with larvae, collected in a drop of normal saline solution, from the labium of two infected *Anopheles*. At the post-mortem on August 4th (a period of *sixteen* days) there was found 'in the subcutaneous tissue near the genitals, a very small female filaria which must be judged *Filaria immitis*, still immature. We were able to preserve only its anterior half sufficiently for diagnosis.' This does not seem to us very satisfactory; details of the appearance and anatomy of this anterior half of an immature *Filaria immitis* not being given.

Filaria recondita. Grassi[2]

The female only is known. This is about 3 cm. long, 0·178 mm. broad. The transparent body tapers towards both ends, more especially posteriorly. The integument is nonstriated. The anterior extremity is obtuse, bears at least four very small papillae close to the buccal orifice. Posterior extremity is also blunt, and has three papillae, one terminal and two lateral, and also several small papilliform projections. The mouth is followed by a very short cylindrical oesophagus, somewhat less than 2·5 mm. long. The anus is at a distance of 228 μ from the tip of the tail. The uterus is double, the vulva at a distance of 840 μ behind the mouth.

Life history. Up to the present only a single female specimen (which was immature, containing neither embryos nor eggs) has been met with. It was found coiled up but not encysted in the adipose tissue near the hilum of the dog's kidney. The embryos have been studied by GRUBY and DELAFOND, LEWIS, MANSON, GRASSI, SONSINO, and others, in France, China, India, and Italy.

1. Grassi and Noé, *British Med. Journal*, 1900. Nov. 3, p. 1306.

2. In a footnote in his article on 'Filariasis' in the *Encyclopaedia Medica*, Vol. III, Nuttall says: 'Sonsino (personal communication, December, 1899) considers it doubtful that this is a 'good species,' the determination having been made upon a single female specimen.'

GRASSI and CALANDRUCCIO[1] traced out the development of the embroyos in *Pulex serraticeps* (of the dog and cat), *Pulex irritans* (of man and dog), and *Rhipicephalus siculus*, KOCH (a dog-tick). They describe the following stages:—

First Stage. Embryo found in the blood of dogs, and in the intestine and body cavity of fleas. Length 280 μ, breadth 5 μ. Body slightly thinned in front, but ending bluntly: behind it tapers and ends in an almost hair-fine point. It is smaller than the embryo of *F. immitis*, and possesses the characteristic that they fix their oral end to the coverglass. At the front end can be made out a fine canal, representing the oesophagus. In those which have reached the body cavity there can be made out a certain trace of the intestinal tract and of the anus. The embryo executes snake-like movements.

Second Stage. Found in the fat cells, seldom free in the body cavity. The larvae of the previous stage first shorten without thickening, then thicken and finally lengthen. The cells of the larvae are larger, and the organs more distinct. The body is cylindrical, and in front has a finger-like papilla 5·6 μ long, covered with cuticle somewhat thickened at the free end, and appearing as though filled with a clear liquid. Long pointed tail. Parts of the alimentary tract are becoming differentiated. The genital apparatus is just appearing. The worm has no movement.

Third Stage. A moulting of the cuticle takes place either in the cell or when free in the body cavity. Length reaches 1·5 mm. The front end is blunt, the papilla of the previous stage disappears. Hind end has three papilla, one terminal dorsal, two other almost terminal, and ventral. The fine point of the tail has disappeared. Further development of the alimentary organs—mouth opening has four papillae. The worm shows active eel-like movements.

Fourth Stage. Only once seen. The larva was encysted, and was considerably larger and thicker. Genital apparatus developed. The tail, besides the papillae, bears a little process (as in adult).

Stages three and four are similar to the adult, and much further development cannot take place.

Attempts, however, to infect dogs with infected fleas failed.

Filaria irritans. Rivolta

Syn. *Dermofilaria irritans.* This name is given to a nematode larva, which measures about 3 mm. in length; its head is slightly marked off by a neck from the body; the tail tapers and terminated in a blunt notched point. The mouth is round, and appears to be provided with lips. At a little distance from the head end an opening is seen. The anus occurs at the point where the body tapers into the tail. The integument bears fine transverse striations.

The *life history* is unknown. These larvae are found in the 'summer sores' or 'granular dermatitis' or horses and donkeys.

1. Grassi and Calandruccio, *Centralblatt für Bakteriologie*, 1890, vii, 18-26

Filaria evansi. Lewis

A description of this species[1] of which the male and female are known, is not procurable. The worms were found in the lung and mesentery of a camel at Madras, the pulmonary arteries being obstructed by masses of tangled worms—the blood containing number embryos similar to those of *F. bancrofti.*

Filaria lachrymalis. Guret

Syn. F. bovis, BAILLET. *F. palpebrarum*, RAILLET. A whitish cylindrical worm, slightly tapering at each end. Cuticle transversely striated. Mouth small, simple, followed by a cylindrical buccal cavity. Anus almost terminal. Male 10-14 mm. long, tail bowed, has two very unequal spicules. Female is 15-24 mm. long, has a straight conical tail. Vulva about 1 mm. from anterior end. Ova ellipsoid, hatch inside the uterus. Embryos 210-230 μ long.

Life history unknown. The adults live in the lachrymal-duct of cattle.

Filaria palpebralis. Wilson

Has a white cylindrical body, slightly tapering at each end. Cuticle has fine transverse striations. Small, simple mouth. Anus almost terminal. Male 8-12 mm. long, tail curved ; bears three pairs of post-anal of papillae and two unequal spicules. The female is 14-22 mm. long, and has a straight conical tail ; the vulva is at 0·60-0·70 mm. from the anterior end. Ova are ellipsoid hatch under the uterus. Embryos have a length of 120-170 μ.

Life history unknown. The adults have been found in the excretory ducts of the lachrymal glands and under the eyelids of the horse.

Filaria osleri. Cobboid

Syn. *Strongylus bronchialis canis*, OSLER.

Body filiform ; mouth surrounded by two or three lips behind which are three unequal papillae ; pharynx swollen. The male is 5 mm. long and has a rounded posterior end ; and two unequal curved spicules. The female is 9-15 mm. long, tapers at each end ; anus almost terminal ; vulva immediately in front of anus ; the worm is ovoviviparous.

Life history unknown. The adults were found by OSLER to be the cause of an epizootic bronchopneumonia in dogs at Montreal. RABE and RUMBERG had previously observed the worm in small nodules in the mucous membrane of the respiratory passages, each nodule containing several male and female worms.

1. Lewis. Remarks on a Nematoid Haematozoon discovered by Dr. Griffith Evans in a Camel. *Proceedings of the Asiatic Society of Bengal*, 1882, p. 63.

Filaria clava. Wedl

The female only is known—length 16-18 mm., breadth 0·33 mm. Body filiform and of uniform thickness throughout almost the whole length. Head end conical; posterior end rounded and bulbous. Mouth simple, small. Anus in a groove at the bulbous end. Vulva at 1·25 mm. from the anterior end. Ova 36 μ by 24 μ contain a coiled-up embryo. Embryo 84 μ long, 6 μ wide, thin rounded anterior end, pointed posterior end. Found in the peritracheal connective tissue of the domestic pigeon.

Filaria mazzanti. Railliet

The female which alone is known is 25 mm. long, 0·25 wide; has a rounded anterior end, conical posterior end. Mouth simple, round. Anus terminal. Vulva triangular, 213 μ from anterior end. Viviparous. Found under the skin of the neck of a pigeon, whose blood contain embryos some 185 μ long with slightly pointed tail, the others 142 μ long with blunt tails.

Filaria uncinata. Rudolphi

Syn. *Spiroptera uncinata*, RUDOLPHI; *Dispharage à queue crochue*, RAILLIET; *F. uncinata*, RUDOLPHI. Mouth has two lips with six papillae. The four sinuous cutaneous bands (characteristic of the *Dispharagi* RAILLIET[1]) reach to within 2 mm. of the anterior end. On each side of the body a double longitudinal series of small spines extends almost to the caudal extremity; in front, the spine ridges reach the dorsal surface and approach the mouth between the cutaneous bands.

The male is 9-10 mm. long; the tail shows straight lateral alae with vesicular edges. Four post-anal papillae; the pre-anal five or six side by side, or seven or eight; the principal spicule is long, incurved and dilated at its free extremity; the other is thick and short.

The female is 15 to 18 mm. long; vulva is at about 1 mm. from the caudal extremity, which is curved.

Life history. This has been worked out by HAMANN[2] in *Daphnia pulex* (RICH). The adults occur in the oesophagus and ventriculus of geese and ducks in tubercles of different sizes which contain worms up to about 10 mm. in length, coiled together. The disease attacks the younger animals of late generations; those of the first brood are unaffected, explained by the course of the development of *Daphnia*. This crustacean multiplies the whole year round, but mostly in the hot summer months, especially of July and August. The mature worms give rise to embryos which wander out of the tumour and may, either, come out by the oesophagus and mouth, or, more usually passed through the intestine, and escape

1. Railliet, *Zool Medic et Agric.* Paris, 1895, p. 542.
2. Hamann, *Central. f. Bakt. u. Paras.*, 1893, xiv, p. 555.

per rectum. They are then taken up by *Daphnia* ; bore through the intestine and lie in the body cavity, reaching 1·7-2 mm. in length. They show a typical mouth with six papillae and a 'vestibulum' ; only the generative organs are lacking. They are then swallowed by ducks and bore into the wall of the stomach and oesophagus. STOSSICH does not include this worm in his list of *Filariae*.

Filaria picae mediae. Manson [1]

The male and female were found coiled up in a small white tubercle in the pocket of the semi-lunar valve ; the worms were encysted, and a minute opening in the covering of the cyst may be present.

The male is about 18·5 mm. long ; diameter at the neck about 0·06 mm. ; greatest diameter about 0·18 mm., of alimentary canal about 0·06 mm., and of spermatic tube 0·08 mm. The tail is strongly incurved. Two spicules. One or two minute caudal papillae. The tail is blunted and slightly lobed and tapers down from the body. The mouth is simple ; oesophagus straight about 0·5 mm. long, terminates in the alimentary canal by a gradual dilatation. Alimentary canal is straight, and filled with a dark granular material. The integument is covered with minute bosses or tubercles, largest about the middle of the animal, less marked towards the head and tail ends.

The female averages about 37 mm. in length ; greatest diameter of unimpregnated specimen about 0·2 mm. ; impregnated about 0·3 mm. The anus is at about 0·12 mm. from the caudal extremity. The vagina is infundibuliform, and opens at 0·25 mm. from the mouth. Mouth, oesophagus and alimentary are similar to those of the male. Expressed embryos measure 0·12 mm. long by 0·004 mm. broad. They have no sheath ; tails are truncated.

In the blood of this bird, MANSON found embryos apparently of two kinds, one about 0·1 mm. long ; the other about 0·22 mm. ; intermediate sizes were also present. The smaller were languid, the larger very active in the movements. A jerking pouting oral movement was seen in both. Tails sharp and pointed.

Filaria corvi torquatis. Manson

The adults occur in the right ventricle, pulmonary artery and its branches.

The male is about 0·3 mm. long ; greatest diameter about 0·16 mm. ; diameter of neck 0·06 mm. Length of oesophagus 0·6 mm. ; diameter 0·04 mm. The body is smooth and very transparent. Mouth simple ; spicules double. No papillae. Tail tapers to a blunt extremity. Anus close to end of tail.

Female 18-20 mm. long ; diameter 0·27 mm. Vagina opens 0·25 mm. from mouth.

The blood of the bird contained two dissimilar embryos ; the larger 0·21 to 0·25 mm. long, and 0·008 mm. broad ; the smaller 0·13 mm. long, 0·004 mm. broad.

1. Manson, *Journal of the Quekett Club*, vol. xi, 1880, p. 130.

The former showed active, lashing, free, vigorous movement; the latter languid, slow wriggling. Oral movements were distinct; there were four papillae round the mouth. The tail of the larger tapered and was pointed; of the smaller, tapered slightly, was truncated, and a thin skin extended like a loose bag or hood from the head end.

MANSON also gives meagre descriptions of haematozoal embryos in *Gracupica nigricollis* and *Goura coronata* (Malay Archipelago).

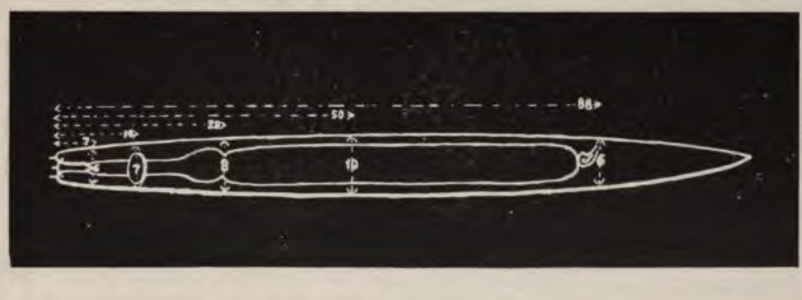
STOSSICH[1] describes in his monograph 212 species of *Filariae*—we have arranged a complete list of these from his work, giving their hosts, and sites, and also the literature referring to each. This list will be found in the Bibliography.

1. Stossich, *Filarie e Spiroptere*, Trieste, 1897.

III. *AVIAN FILARIAE.*—New Species

This description of new blood filariae discovered in West African birds of different species includes the account of eight new species, of which the adult forms generally both male and female were found, as well as the blood embryos, and also of three species in which blood embryos alone were met with.

With a view to obtaining some uniformity in the descriptions and measurements of Nematode worms in general, Cobb[1] has devised an ingenious formula, for the account of which we are indebted to Shipley[2], in which measurements of different parts appear as percentages of the whole length of the body. The following diagram explains the nature of the formula, which, however, should be used with caution since it rests on the assumption, as Shipley[2] points out, that the proportions of the various parts of the body are constant in different individuals, and it is by no means certain that this is the case.



In the diagram, 6, 7, 8, 10, and 6 are the transverse measurements, while 7, 14, 28, 50, and 88 are the corresponding longitudinal measurements. The formula in this case is

$$\frac{7 \quad 14 \quad 28 \quad 50 \quad 88}{6 \quad 7 \quad 8 \quad 10 \quad 6}.$$

The unit of measurement is the one-hundredth part of the length of the worm, so that the measurements are therefore percentages of the length. The measurements are taken with the animal viewed in profile; the first is taken at the base of the oesophagus, the second at the nerve ring, the third at the cardiac constriction, the fourth at the vulva in the female and at the middle in the male, the fifth at the anus.

1. Cobb, *Macleay Memorial Volume*, Sidney, 1893, p. 252; and *Proc. Linnean Society*, N.S.W. Second series, Vol. V, 1890, p. 449.
2. Shipley, Harmer and Shipley, *Cambridge Natural History*, Vol. II, *Worms*, etc., p. 138.

This plan will be followed as nearly as possible in the following descriptions :—

Filaria cypseli. Nov. Sp.

Definitive host—Cypselus affinis. The West African swift. The infected birds were found to have built their nests among the rafters supporting the verandah of the telegraph station of the African Direct Telegraph Company at Bonny, Southern Nigeria ; and in the neighbouring palm trees.

Site. The adult filariae were found in the subcutaneous tissues of the head and neck. In one bird six worms occurred, four of which were mature females, one an immature female, and the sixth a mature male ; in another two females and one male. Some came off with the skin on stripping the scalp ; two were found in the neck, one of them extending as far down as the middle of the back. They were not coiled up but lay more or less straight among the subcutaneous tissues. They were observed to move in the tissue with a slow sinuous motion backwards and forwards, and could be kept alive in normal salt solution for about ten hours.

The adult worms are very long and thin, white in colour. The cuticle shows faint transverse striations. The female has an average length of 25·3 mm.—the length varying in our specimens from 24·0 to 26·7 mm. (the immature female measured only 16 mm. long). The breadth of the body is 0·22 mm.

$$\text{Cobb's formula is : } \frac{-,\ 0{\cdot}54,\ 1{\cdot}7,\ 2{\cdot}5,\ t,^{*}}{-,\ 0{\cdot}8,\ 0{\cdot}88,\ 0{\cdot}84,\ 0{\cdot}8,},$$

The head end [plate I, fig. 2] is somewhat bulbous, and has the shape of a short cone slightly flattened at the apex—which is the position of the oral orifice. On the rim of the slightly flattened area are four minute papillae. The oral orifice is placed centrally—no buccal appendages can be made out. The buccal cavity is continued backwards into a thick-walled narrow-lumened oesophagus, which is 0·45 mm. long, bulbous posteriorly, and distinctly marked off by a constriction from the rest of the alimentary tract. What appears to be the nerve collar or commissure crosses the oesophagus at a distance of about one quarter of its length from the anterior end. The gut is continued almost straight down the length of the worm, curving only from side to side, and ending at the terminally placed anus. The position of the anal orifice is indicated by a depression placed slightly subterminally. The tail end does not taper, but is slightly swollen at the extreme end, which is very abruptly rounded off. (Plate I, fig. 3). The vaginal orifice is situated at a distance of 0·7 mm. from the anterior end, and is placed at the centre of a small conical papilla. Two minute pre- and two post-vaginal spines can be made out (there may be six in all). The vagina which has thick muscular walls is directed generally backwards, but according to the state of engorgement of the uterus it may first go a little backwards and then

* *t* denotes that the position of the anus is terminal.

make a loop forwards before turning; it coils backwards to a point about one-quarter down the length of the worm and receives the two horns of the uterus. In ripe specimens the vagina is seen packed with numerous outstretched embryos arranged longitudinally. The two uterine horns make many longitudinal coils and twists round each other, which may extend up as far as the junction of the oesophagus and intestine and backwards to the posterior end of the worm. Near their termination they narrow considerably and end in long blunt nodular extremities in the posterior quarter of the worm. In the mature worm the contents are first granular in the narrowed terminal portion; the granules increasing in size further on until distinct ova are made out. Beyond this they contain embryos coiled up in the vitelline membranes which, when the embryos have straightened themselves out, are seen to form the embryonic sheaths. In some of our specimens many embryos enveloped in their characteristic sheaths have escaped. These and the ova are found to have the following measurements :—

Length of ovum containing coiled up embryo	36 μ
Breadth „ „ „ „	23 μ
Length of freshly hatched embryo	76·5 μ
Breadth „ „	8·2 μ

The male is much smaller than the female. It is found in similar positions, and in general characters resembles the female, although it is shorter and thinner: it is characterised in preserved specimens by the strongly incurved tail, which makes two almost complete turns. Its average length is 7·5 mm., its breadth 0·15 mm.

$$\text{Cobb's formula}: \frac{-}{--}, \frac{1\cdot02, 4\cdot07, \underline{50}, t,}{1\cdot63, 1\cdot63, 1\cdot02,}$$

The head end (plate I, fig. 4) is similar in shape to that of the female. The length of the oesophagus is 0·32 mm. There is a distinct cardiac constriction. The anal orifice appears to be placed, not exactly terminal, but rather on the ventral surface. There are three pairs of pre-anal and one pair of post-anal papillae; the posterior two of the pre-anal series are larger, and are united by low ridges with the corresponding papillae of the opposite side. There are two spicules of unequal length—not extruded in our specimens. The tail end (plate I, fig. 5) does not taper, the extremity somewhat resembles that of the female, except that dorsally it is not so abruptly rounded off.

The embryo. The habitat of the embryo seemed to be essentially the lymph. In the process of the preparation of our specimens, it was often observed that in those made from the blood of the claws and legs by puncture of a small blood-vessel, one only, out of many slides, was occasionally found to contain very few embryos; many contained none at all. Moreover, we never found any embryos in the heart's

blood. On more careful examination it was found that the claws appeared somewhat oedematous, and by careful manipulation we were able to obtain specimens of the serous fluid, which contained large numbers of the embryos.

The embryo (plate I, fig. 1) in the fresh condition as seen in lymph and some blood preparations was 84·7 μ long. The breadth of the sheath of the embryo, 12·78 μ; of the embryo itself inside its sheath, 7·9 μ. When fresh the embryos exhibited a slow sinuous progressive movement: while, inside the sheath they were much more active. The two ends of the worm continually moved about, so that the tips seemed always in contact with the inner surface of the bluntly conical end of the sheath—the ends never being observed retracted from the sheath. This movement of the extremities inside the sheath, which appears a little too short for the embryo, causes the body of the embryo to be thrown into two curves, the sheath crinkling a little opposite the concavities of the curves. Ecdysis was not observed.

Both extremities of the embryo are bluntly rounded. At the anterior extremity is a short stout conical papilla from the apex of which projects a short thick spine which is always closely applied to the inner surface of the rounded end of the sheath. There is no prepuce, but a distinct ridge marks off the body from the papilla: neither spine nor papilla was observed to be withdrawn. Under high powers a central line appears to run down from the papilla into the body. The anterior portion of the body of the embryo tapers very slightly. The contents are finely granular, a larger more refractile granule appearing at a point at about a quarter of the length from the posterior end. At this end the worm has a short rather broad, highly refractile tubercle which is always in contact with the sheath, and moves from side to side along the concavity of the end of the sheath.

In fixed and stained specimens, in all of which the embryo is found shrunk in various degrees inside its capsule, the length varies from 75 to 84·7 μ. The nuclei of the very small cells are evident, but indications of V-shaped or other shaped spots are very indefinite and irregular.

Filaria spiralis avium. Nov. Sp.

Definitive hosts.—*Hyphantornis aurantius.*
Cyanomitra reichenbachi.
Muscicapidarum. Sp. dub.
Pyenonotus barbatus.
Sitagra brachyptera.
Vidua principalis.
Cinnyris fuliginosa.
Cypselus affinis.

Site. The adult worms were always found in swellings about the feet and ankles of these birds. The infected birds were easy to detect by the presence of small, soft, subcutaneous tumours in these positions; the skin over these tumours was stretched, and the superficial veins appeared dilated.

The small nodules occurred in various positions: for example in one bird—on the right foot, a tumour on the upper surface of the second phalanx of the first toe, and in a similar position on the second toe; a third on the under surface of terminal phalanx of the fourth toe; another over the distal end of tarsus. In the left foot—a large swelling under the distal end of the tarsus; two on the first toe, one at its extreme base on the under surface, the other on the under surface of the terminal phalanx; and one on the lateral outer surface of the fourth toe. In another bird, one tumour was found higher up, in the tarsus among the tendons; others just at the base of the claws, under the insertion of the flexor tendons.

The worms occupied cysts in the positions mentioned, from two to ten worms in each cyst, which seemed to be intimately connected with the sheaths of the tendons. The worms were coiled together inside the cyst; the whole clump of them being easily turned out on slitting up the tumour, with a mass of yellow coloured jelly-like fluid, which surrounded the worms.

The worms in the cysts varied in colour from pale yellow to brown, the younger worms being generally brown. Some were considerably larger than others. They have a decidedly corkscrew shape, the screw having two to four turns according to the length of the worm. Introduced into normal salt solution the worms retained their corkscrew shape and moved for some time with a sluggish corkscrew motion. The shape is kept in preserved specimens. The screw of both male and female worms is a right-handed one, these facilitating the arrangement of a large number into the smallest space.

The female :—The total length varies from 4·4 to 8·4 mm., the central breadth about 0·34 mm. The worm makes three or four coils.

$$\text{Cobb's formula}: \frac{—,\ 1{\cdot}8,\ 10{\cdot}2,\ 4{\cdot}3,\ 99{\cdot}2}{—,\ 1{\cdot}2,\ 2{\cdot}8,\ 1{\cdot}7,\ 0{\cdot}94},$$

The anterior and posterior portions of the worms beyond the beginning and end of the spiral are somewhat flattened; the anterior portion is longer than the posterior, and more sharply pointed. The cuticle is thick, transparent, and yellowish in colour: over the extreme ends it is thin. Laterally in the anterior portion the cuticle is thickened, the two lateral thickenings being continued down throughout the length of the worm, so that in optical sections of the convexities of the spirals they appear as knobs, of the concavities as thickenings.

The anterior endo the worm (plate II, fig. 2) which is tapered from the point of junction with the spiral proper, is rounded; there is a slight narrowing for a neck. The position of the oral orifice is marked as a small dent in the cuticle. No

papillae nor tubercles are evident. The long oesophagus, extending down beyond the vaginal orifice, is about 0·75 mm. long, and bears a narrow bulb marked off from the intestine by a slight constriction often hidden by the vagina. The gut extends along the whole length of the worm, and terminates at the anus on the ventral surface just in front of the posterior extremity of the worm. The anal orifice is surrounded by five delicate lips giving a rosette appearance. Side view the position of the orifice is marked by a slight baying (plate II, figs. 3 and 4). The vulva is at a distance of about 0·33 mm. from the head end, and appears to open ventro-laterally. The vagina runs, for a short way, directly backwards, makes a coil towards the head end, and runs down. The first portion is very thick-walled with small lumen ; beyond this the walls get thinner, and the lumen is seen packed with stretched-out embryos. The vagina receives the two horns of the uterus, which coil and twist round each other, and extend to the posterior end of the worm. Each horn has muscular walls at its entrance into the vagina; the muscular walls get thinner and the lumen narrows somewhat in diameter until a kind of neck is reached following a distinct bulbous swelling, in the region of which the muscular walls are much thicker, forming a sort of ' pylorus.' Beyond this the tube again narrows, the walls are very thick, so that only a narrow lumen is apparent. At the junction of this thick--walled tube (oviduct) with the bulbous swelling (uterus), the former projects into the cavity of the latter to form a papilla with an opening at its centre. Beyond this thick-walled oviduct is the ovary—a long wider thin-walled portion, which further on narrows considerably, becoming cord-like, and ends in a terminal bulb, immediately in front of which is a small swelling. The length of the ovary is about 1·7 mm.—of the oviduct 0·9 mm. The total length from vulva to the end of the ovary is about 26 mm.

Mature ova—spherical cells having large rounded nuclei and distinct nucleoli—are found in the large dilated proximal portion of the ovary. The narrow-lumened oviduct is empty. The cavity of the uterus near its junction with the oviduct, and for some distance down contains innumerable spermatozoa surrounding several ova. Beyond this, the uterus contains ova in all stages of development.*

Length of ovum containing embryo 39 μ.
Breadth „ „ „ 27 μ.
Length of embryo with its sheath 236 μ.
Breadth „ „ 5 to 6 μ.

The male is similar to the female in appearance but considerably smaller ; it makes two or three spirals. The tail end has its tip curled ventrally. Length of worm 3·4 to 3·7 mm.; breadth 0·2 to 0·3 mm.

Cobb's formula $\frac{—,\ 2{\cdot}3,\ 15{\cdot}7,\ 50,\ 98{\cdot}6}{—,\ 1{\cdot}9,\ 3{\cdot}8,\ 4{\cdot}6,\ 1{\cdot}5}$;

*A more detailed account of the histology of the reproductive and other systems of these worms will form the subject of a subsequent article.

The anterior end resembles that of the female but is smaller. The oesophagus is 0·57 mm. long (in one very transparent specimen only, a distinct cardiac constriction could be made out). The anal orifice is at a point 0·08 mm. from the tip of the tail (plate III, figs. 1 and 2). Four pre-anal and three post-anal papillae on each side could be made out; the two last post-anal being very small. The genital orifice is in the median line at the apex of a slight raised prominence. On each side of this prominence are two cuticular expansions, bearing the papillae and forming continuations of the lateral cuticular ridges. There are two curved unequal retractile spicules, the ventral of which, shorter than the dorsal, appears to be hollowed out on its dorsal surface for the latter's reception. The dorsal spicule is rod shaped and ends in a round knob. The other seems to widen at its deeper end and bends round the sides of the dorsal. The spermatic canal runs up the worm from the neighbourhood of the base of the spicules as a single narrow tube which soon widens to fill up almost the whole of the body cavity. A short distance from the head it becomes somewhat narrower, and ends after making a few turns in this region.

The embryos are found in large numbers in the peripheral and in the heart's blood. They have a sheath which is a long narrow cylinder with rounded ends. In fresh specimens the embryos exhibit a simple snake-like lashing movement, progressing forwards and backwards, and also a backward and forward motion inside the sheath. Some were seen to coil themselves up closely. The worm with its sheath (plate XIII, fig. 2) has a uniform thickness, except at the posterior end where it suddenly diminishes into a wall-marked 'tail.' The length of the worm inside the sheath was 208·6 μ, breadth 1·7 μ. In the living specimens two longitudinal lines of fine refractile granules can be observed, one about the junction of the anterior and middle thirds, the other about the junction of the middle and posterior thirds. The head end is rounded, no definite prepuce nor spine could be made out, beyond a highly refractile 'glans'-like tip. At the tail end the width of the worm suddenly diminishes at a distance of about 6·5 μ from the extreme tip to about 2 μ. The tail comes off eccentrically.

In stained specimens (plate III, fig. 5) no characteristic position is acquired. The average length of the worm, which varies considerably, is 216·8 μ. The column of small nucleated cells forming the body, at the head end is bayed out so that the end appears bifid. Five 'spots' (V- or otherwise-shaped) can be made out; their numbers however varies from three to five.

On examination of a number of embryos the distances of the spots from the end of the worm relatively to its length proves to be fairly constant, and we shall adopt throughout this work a method similar to Conn's to indicate their positions:

2. A clear sometimes lateral, sometimes transverse spot; distance 35.3; constant.
3. A long space in which the nuclei are loosely arranged, often anteriorly and posteriorly ending in a clear space, with the nuclei more densely arranged in between; distance 66·7; constant.
4. A small spot only occasionally seen, at 76; sometimes merges into the third spot.
5. A very small lateral spot sometimes absent; distance 89·5.

Filaria fusiformis avium. Nov. Spec.

Definitive hosts : *Spermestus cucullatus.*
Hyphantornis. Sp. incert.
Hyphantornis aurantus.

Sites. The adult forms were found in the mesentery at the under surface of the liver and in the lung. The collection comprises two males, four females, and three immature worms: of which two were found in one bird; a single one in another; another single one in a bird whose blood contained also embryos of *F. spiralis* and *F. opobensis*; the others in a fourth.

The female is a long whitish worm, tapering gradually for some considerable distance at each end. The length varies from 15·8 to 25·5 mm.; breadth about 0·28 mm.

$$\text{Cobb's formula : } \frac{—,\ 0{\cdot}67,\ —,\ 1{\cdot}6,\ —}{—,\ 0{\cdot}27,\ —,\ 0{\cdot}33,\ —}$$

The cuticle is thin, smooth and transparent, somewhat thickened at the head end. The worms are all very opaque, so that but little of the internal anatomy can be made out in preserved specimens. At the anterior end (plate IV, fig. 2) which tapers to a breadth of 0·05 mm., is a slight appearance of a somewhat narrower neck. The oral orifice is terminal; no papillae nor spines apparent. The vulva is at a distance of about 0·43 mm. from the anterior end. The anus is terminal. The posterior end also tapers considerably to 0·05 mm., and is then abruptly rounded off (plate IV, fig. 3). The ovum measures 27·7 μ by 24·7 μ, and the length of the embryo inside the sheath in the preserved condition is 120 μ. The male, one specimen only of which is suitable for description, is 11·8 mm. long, 0·16 mm. broad.

$$\text{Cobb's formula : } \frac{—,\ —,\ —,\ 50,\ 0{\cdot}88}{,\ —,\ —,\ 13{\cdot}8,\ 0{\cdot}47}$$

The cuticle shows no obvious striation. The head end resembles that of the female in shape; it is provided with four small tubercles round the oral orifice. The posterior third of the worm tapers and coils, the coiling increasing towards the end of the tail. The anal orifice opens at a distance of about 0·14 mm. from the tip of the tail. There are two unequal spicules. The specimen is too opaque to make out any further internal anatomy.

The *embryos* are found in the peripheral and in the heart's blood. Its length in the fresh condition is 117 μ, breadth, 3 μ. It has a very marked sheath which can often be seen trailing in front or behind the worm in the fresh specimen (plate XIII, fig. 3). The embryos move backwards or forwards with snaky movements, and also rush very energetically forwards and backwards inside their sheaths. The head end is rounded and has a six lipped prepuce through which a conical papilla can be observed to be protruded ; this bears at its apex a fine projecting spine. The papilla and its spine can be retracted within its sheath—an action very actively performed in fresh microscopical preparations. The body contents appear finely granular ; at the junction of the anterior and middle thirds is a highly refractile spot. The tail end tapers very slightly and ends bluntly rounded. In stained specimens (plate IV, fig. 4), the length of the embryo is 86·0 μ ; the length of the sheath beyond the worm proper both anteriorly and posteriorly varies enormously. The head end shews generally only a looseness in the arrangement of the small cells—sometimes a baying.

Spots.—1. A narrow transverse slit—fairly constant ; distance 28·6.
2. A lateral rounded bay—not always present ; distance 40·7.
3. A clear band across the worm—constant ; distance 69·2.
4. A small lateral slit—only occasionally seen ; distance 90·0.

Spots 2 and 4 are always on the same side of the worm.

Filaria spiralis avium major. Nov. Sp.

Definitive hosts : *Hyphantornis.* Sp. incert.
Sitagra brachyptera.
Hyphantornis aurantius.

Site. In *Sitagra brachyptera* the adult worms were found in a thick walled cyst on the right leg situated deeply under the tendons on the bone. The cyst contained one small (male) and two large (female) worms. This bird also contained embryos and adults of *F. spiralis.* Although similar in appearance and site the two worms are quite distinct, the female of *F. spiralis major* being three or four times the length of the female of *F. spiralis*—and moreover they have different embryos, a fact conclusively demonstrated by the rupture of the uterus in each case and the examination of the contained embryos.

The female, spiral in form, has nine turns. The spiral is right-handed. The total length is 17·3 mm., the central breadth 0·43 mm.

Cobb's formula : $\frac{\text{—}, \text{—}, \text{—}, 2\cdot4, t}{\text{—}, \text{—}, \text{—}, 0\cdot64\text{—}}$

Similarly to *F. Spiralis*, there is an anterior and posterior portion beyond the spiral, the anterior of which is the longer. The cuticle at the anterior end is thin, but thicker at the posterior end. Laterally the cuticle is thickened, and along the

convexities of the worm is seen to be distinctly striated transversely. The outer lateral ridge bears a number of flattened transparent nodules, the distribution of which seems to be irregular, in places appearing to be grouped into twos, threes, or fours. The striations of the cuticle become spread out in the nodules. The striations are less distinct along the other lateral border of the worm. The anterior portion (plate V, fig. 2) tapers considerably ; its extremity is rounded ; the oral orifice is central and terminal—no papillae or other appendages could be made out. The anus is in a position similar to that of *F. spiralis* (plate V, fig 3). The vagina opens at a distance of 0·45 mm. from the anterior end. The opacity of the worms makes it difficult to observe further the internal anatomy. The nodulated cuticle is very characteristic.

The male is much shorter and thinner than the female and has six coils. The tail end is markedly incurved. The length of the worm is 9·0 mm., breadth 0·125 mm.

$$\text{Cobb's formula } \frac{\text{---}, \text{---}, 3{\cdot}4, 50, 99{\cdot}2}{\text{---}, \text{---}, 0{\cdot}93, 1{\cdot}4, 0{\cdot}46}$$

The cuticle is ridged, knobbed, and striated, similarly to that of the female. Beneath the lateral ridges in the musculo-cutaneous structure is a dark brown granular pigmented layer: the pigment, apparently intracellular, is regularly interrupted by what appear to be large unpigmented nuclei. The head end (plate V, fig. 4) is similar to that of the female. The oesophageal bulb is very indistinctly marked. The anal aperture is at a distance of 0·058 mm. from the tip of the tail, and is at the centre of a low flat papilla. Three pre-anal, and two post-anal papillae could be made out on each side, the former being very small and close together, almost continuous with one another. There are two unequal spicules, their terminal extremities have a rosette appearance. The origin of the reproductive tube can be seen to commence as a thin single tube coiled about the neighbourhood of the commencement of the intestine, which increases in size to fill almost completely the whole body cavity up to the last coil of the worm where the tube becomes thinner and its walls more muscular till it ends at the rosette horns of the spicules. The tail end differs from that of *F. spiralis* having no expansions of the lateral cuticular ridges, these disappearing altogether as the tail is reached. The tip is bluntly rounded off on the dorsal surface. (Plate V, fig. 5).

The *embryos* are found in peripheral and central blood. In the fresh condition they measure 141·7 μ in length, 6.5 μ in breadth. They exhibit forward and backward sinuous progressive movements. They have a well marked thick cuticle which shews distinct transverse striations (plate XIII, fig. 4). They taper very slightly towards the anterior end, very abruptly posteriorly, so that this end resembles in shape the point of a wire nail. The head end is bluntly rounded and has a small clear area—no prepuce nor spine could be made out. At the tail end the cuticle is well seen.

In stained specimens (plate VI, fig. 1) the cuticle is also well marked. The worm measures 119·3 μ in length. The embryos on fixing take up no characteristic position. At the head end the cell column is bifid. Four 'spots' are generally made out:

1. Slit like, at a distance of 29·2 per cent. of total length.
2. A small lateral bay; distance 42·6.
3. An oval-shaped spot occupying the breadth of the worm, containing only a few small nuclei; distance 64·4.
4. A small lateral break; distance 89·9.

The two lateral spots (2 and 4) are on the same side of the worm. All the spots are constant, but the first and second are sometimes badly marked.

Filaria falciformis. Nov. Sp.

Definitive Host: *Cinnyris fuliginosa.*

Site. The subcutaneous tissue of the back of the head, dorsum of wing, root of neck, and leg.

In one bird of this species three males and two females were found; in the second, one male and one female (with adult forms of *F. bibulbosa*); in another, one male and three females (also with some adults of *F. bibulbosa*), and in the fourth, one male and three females.

The female varies in length from 20·3 to 29·4 mm.; its breadth is about 0·23 mm.

$$\text{Cobb's formula: } \frac{-,\ 0{\cdot}58,\ 0{\cdot}76,\ 28{\cdot}7,\ 98{\cdot}9}{-,\ 0{\cdot}62,\ 0{\cdot}62,\ 0{\cdot}69,\ 0{\cdot}31}$$

It is creamy white in colour; a long thin worm with a slightly curved tail end. The transversely striated cuticle is finely ridged, the ridging disappearing near the head end. The head end (plate VII, fig. 2) is bluntly rounded, and tapers slightly. The mouth is terminal, and is simple, bearing no papillae. The oesophagus is a straight thick-walled tube, and has no bulbous ending; the intestine commences suddenly as a broad tube full of dark granular substance, with here and there large irregularly angular masses of orange-coloured material. The position of the anus is on an average at 0·38 mm. from the posterior end; the orifice is at the summit of a low flattened papilla. No anal papillae can be made out. The body rapidly tapers beyond the anal aperture and ends in a cone-shaped portion 0·047 mm. across at its base (plate VII, fig. 3). The vulva is situated at 0·774 mm. from the head end of the worm, at the apex of a nipple-shaped papilla. The vagina courses down the worm, or may make a twist upon itself: it divides at about 1·5 mm. from its orifice into the two uterine horns, which, coiling many times on themselves, occupy almost the whole of the coelomic cavity. They end in a somewhat similar manner to that described under *F. spiralis*, except that no evidence of the existence of a 'pylorus' can be made out, and moreover, the extreme end is not bulbous.

The ovum, containing a coiled-up embryo, measures 27·7 μ by 19·5 μ. The embryo is 112 μ long by 4·2 μ wide.

The male is much shorter than the female, and very active when freshly introduced into normal salt solution. It is very slender, and has a well marked incurved tail. It measures 11·6 to 14·8 mm. long, and its breadth averages 0·136 mm.

$$\text{Cobb's formula : } \frac{—,\ 1{\cdot}29,\ 2{\cdot}53,\ 50,\ 98{\cdot}8}{—,\ 1.04,\ 1{\cdot}04,\ 1{\cdot}38,\ 0{\cdot}69}$$

The cuticle is striated and ridged as in the female. The head end (plate VII, fig. 4) is also similar to that of the female. The mouth is terminal and simple: there are no appendages.

The length of the oesophagus is 0·03 mm., there is no bulb. The anal orifice is at 0·149 mm. from the tip of the tail. The reproductive system consists of a single tube commencing thin, gradually increasing in width and occupying the greater part of the body cavity; it seems to end in connection with the bases of the spicules. The tip of the tail (plate VII, fig. 5) has four papillae, two of which are terminal so that the end appears bifid: the other two are placed dorso-ventrally to these and are much smaller. In front of these on the ventral surface are four papillae arranged in two pairs; while still further forward are two other post-anal papillae on each side; no pre-anal papillae could be made out. There are two unequal spicules, in many of the specimens extruded. (Plate VII, fig. 5, and plate VIII, fig. 1). The orifice (16·3 μ across) through which they protrude resembles a wide crater with sharply defined edges at the summit of a low cone. The dorsal spicule seems to widen at its base and embrace the ventral; this spicule is pointed.

The *embryos* are found in the peripheral and central blood. The length varies very much in the fresh condition from 91 to 107·5 μ: the embryo can be seen stretching itself considerably. Breadth 3·26 μ. There is no sheath (plate XIII, fig. 5). The head end is blunt and there is some differentiation into a small papillae bearing a short stumpy spine. The tail end tapers a little and ends bluntly. The contents of the body of the worm are somewhat closely granular. In the fresh condition this embryo is characterised by the possession of a very distinct oval very highly refractile globule behind the middle point of the worm, almost at the junction of the middle and posterior thirds.

In stained specimens (plate VIII, fig. 2) the embryos only measure 87·3 μ on an average. The anterior bay in the column of cells at the head end is well marked.

The cells in these specimens appear to be loosely arranged. Four spots can sometimes be seen, but three of them are extremely variable. Sometimes one only, sometimes two, three, or four are present. One is constant—the third, and is a distinguishing feature of this embryo.

1. A small slit at a distance of 25·4 per cent. of the length of the worm.
2. A **V** which may extend across the breadth of the worm, distance 34·4.

3. A band across the worm about 4 μ wide—distance 62·2 (corresponds in position to that of the highly refractile granule seen in fresh specimens.
4. A slight lateral bay, distance 83·7.

Filaria bibulbosa. Nov. Sp.

Definitive hosts : *Cinnyris fuliginosa.*

Sites. Subcutaneously, in various positions. The worms generally occurred in pairs, male and female together. Our collection contains a single male and female in one position from one bird, and a single male from another position : this bird also contained adults. Two females were found in one bird of the same species, which also contain *F. spiralis.*

The female is a long, thin, whitish, smooth worm, both ends of which are bulbous. Its length varies from 20·7 to 22·7 mm.; its breadth is about 0·17 mm.

$$\text{Cobb's formula : } \frac{—,\ 0{\cdot}09,\ 0{\cdot}10,\ 0{\cdot}29,\ t}{—,\ 0{\cdot}05,\ 0{\cdot}05,\ 0{\cdot}05,\ 0{\cdot}06}$$

The cuticle is somewhat thick, smooth, not striated. There is a slight narrowing for a neck (0.13 mm. wide) separating off the bulbous head end (0·17 mm.) (plate VIII, fig 4). The mouth is terminal; no papillae nor other appendages discernible. The oesophagus is straight, has no bulb; length 0·25 mm. The anus (plate VIII, fig. 5) is terminal and central, and is surrounded by four small lips. The vulva is 0·65 mm. from the anterior end : it is situated on a low conical papilla. The vagina is directed backwards, but may coil forwards as in other filariae. The uterine horns resemble those of others previously described. The two extreme ends are bulbous; no 'pylorus' could be made out.

The male is smaller and thinner than the female, otherwise similar in appearance ; the tail end is not incurved. Length 8·6 mm. ; breadth 0·09 mm.

$$\text{Cobb's formula : } \frac{—,\ 1{\cdot}86,\ 2{\cdot}26,\ 50,\ t}{—,\ 0{\cdot}93,\ 0{,}93,\ 0{\cdot}93,\ 0{\cdot}93}$$

Width of head 0·1 : of neck 0·07 mm. The head end, mouth and oesophagus are similar to those parts in the female (plate IX, fig. 1). Posteriorly the dorsal surface is rounded off to meet the ventral surface at an angle, at which the anal orifice is situated (plate IX, fig. 2). The region round the aperture is slightly flattened. In both of the specimens in our possession, one of the spicules of this worm is extruded through the orifice. It is curved and sharply pointed ; the other appears to ensheath the former. Only one small (probably a pair) post-anal papilla can be discerned. The reproductive tube is similar to that of the other filariae.

The *embyros* are found in the blood, both peripheral and central. They have no sheath : they are capable of progression in both directions, exhibiting sinuous movements (plate XIII, fig. 6). Length 117·4 μ, breadth 4·9 μ. The body is plain

and appears structureless. The front end is bluntly rounded ; and has no prepuce nor spine : the tail end tapers gradually from almost the middle of the worm to the tip of the tail.

In stained specimens (plate IX, fig. 3) the embryos set in characteristic comma-like position. The embryos measure 97·8 μ in length.

The head end does not show a baying, but simply a looseness in the cell arrangement. The following spots are always present :

1. A small central irregular clearing, at distance 22·5 per cent. of length.
2. A similar central irregularly shaped clearing, larger than the first, distance 33·5.
3. The largest spot, oval in shape, distance 60·7.
4. A tail spot, the second largest, well marked, oval, at 81·8

Filaria capsulata. Nov. Sp.

Definitive hosts : *Pyenonotus barbatus.*
Sitagra brachyptera.
Hyphantornis. Sp. incert.

Sites. In *Pyenonotus barbatus*, in the tissues between the oesophagus and spinal cord, were found three bundles which microscopically appeared to consist of a thin membranous capsule containing a worm or worms coiled up. These on dissection were found each to consist of a thin connective tissue capsule with two worms, a long one and a short one coiled up, in its interior.

In another bird of the same species were found five encysted worms between the oesophagus and spine ; there was no free worm, but on dissection of one of these cysts the head of a worm was found to project about 1·0 mm. length out of the cyst. One of the cysts was very small ; another large one contained a yellow coloured lightly mottled worm.

In still another bird of this species ten flattened masses were found in similar positions ; they looked like bags of whitish jelly containing coiled worms. They were directly subcutaneous or on the muscle fascia with delicate fibrous tissue bands anchoring them to the tissues below, so as to permit of some movement but requiring dissection for removal. The positions in which they were found were :—one on the back of the head, three in the neck, two between the trachea and muscles of the spinal column, another at the base of the neck, one at the lower edge of the pectoral muscular mass laterally, two on the thigh.

Apparently each sack contains two worms ; some of these were purposely torn across—characteristic ova and embryos issued from the ruptured uterus.

In *Sitagra brachyptera* in a single case the site was lower down the oesophagus—a cyst of yellowish colour was found between oesophagus and liver. This bird also contained embryos and adults of *F. spiralis* and *F. spiralis major.*

In the *Hyphantornis* a cyst occurred under the skin of the thigh and contained two worms.

The cyst (plate X, figs. 1 and 2) is a thin-walled delicate fibrous tissue capsule which is whitish in colour, almost transparent and closely applied to the worms which it contains. The worms are often difficult to separate entirely from the enveloping capsule. The cysts seem to contain no or extremely little fluid; each has always two worms, a male and a female. The colour of the contents varies from white to yellow, according to the colour of the contents of the intestine canal of the worms. The dimensions of the capsule vary: the largest was 5·7 by 3·4 mm., the smallest 1·8 by 1·2 mm.

The female worm, in one completely dissected-out specimen, measured 40·6 mm., breadth 0·44 mm.

$$\text{Cobb's formula: } \frac{\text{—, 0·98, 1·86, 1·26, } t}{\text{—, 0·69, 0·86, 0.75—}}$$

The cuticle is thin and smooth.

The head end (plate X, fig. 3) tapers somewhat, and is bluntly rounded. The mouth is terminal; there are no papillae nor other appendages. The oesophagus is straight, has no bulb; it is 0·54 mm. long, is light in colour, and indistinctly marked off from the darker intestinal tract. In the tract of many specimens are numerous bright orange-coloured round clumps of material—which give rise to the yellow colour of the worm. These clumps are irregularly shaped—some round and others angular. The tail end (plate X, fig. 4) is bluntly rounded; the anal orifice is terminal. The vulva is situated on a small conical papilla, 0·25 mm. from the anterior end. The vagina extends directly, or after one or two forward twists, down the body of the worm for 1·6 mm. distance from the orifice, where it receives the two uterine horns. These resemble those of the *Filaria* already described. There is a well marked 'pylorus' beyond which the tube is continued for 4·48 mm., to terminate in a blunt, slightly nodular end. The ova, containing coiled-up embryos, measure 26 μ by 19·5 μ. The embryos are 81 μ long.

The male in shape and appearance resembles the female, but is much smaller. Length 4·5 mm.; breadth 0·17 mm.

$$\text{Cobb's formula: } \frac{\text{—, 3·64, 9·26, 50, 97·6}}{\text{—, 2·64, 2·64, 3.80, 2·32}}$$

The ends, both anterior (plate XI, figs. 1 and 2) and posterior (plate XI, figs. 1 and 2) are similar to those of the female. Width of head, 0.11 mm.; of tail end, 0·10 mm. Length of oesophagus, 0·39 mm. The anus is ventrally placed, a little in front of the posterior end of the worm. There are probably two spicules: one, sharply pointed, is extruded in some specimens; the other could be but very indistinctly made out.

The *embryos* occur in both central and peripheral blood. They have no sheath. Length in the fresh blood 94·5 μ, breadth 3·5 μ. The head end is slightly

tapered. The tail end tapers very gradually for the last third of the length of the worm and then at a distance of about 10 μ from the tip more rapidly, to end bluntly. The contents of the body of the worm are granular (plate XIV, fig. 7).

In stained specimens (plate X, fig. 5) the length of the embryo only averages 81·5 μ. The column of cell nuclei at the head end appears abruptly broken off—there is some looseness of the cells here also.

The 'spots': generally two are seen, sometimes only one, which is constant.

1. A narrow slit or break in the cell column; distance 32·9 per cent. of whole length.
2. Oval in shape, occupies the whole breadth of the worm; distance 58·5. This spot is constant.

Filaria shekletoni. Nov. Sp.

Definitive hosts: *Cypselus affinis.*
Hyphantornis aurantus.

Site. In *Cypselus affinis* our only two specimens, both females, were found, one lying under the pericardium along the whole length of the heart; the other in the peritoneal cavity on the upper surface of the liver. On breaking one of these, numerous embryos, similar to those found in the heart's blood, emerged.

The female is white in colour, 12·5 mm. long, 0·29 mm. broad.

$$\text{Cobb's formula: } \frac{\text{—, 1·66, 4·22, 33.4, } t}{\text{—, 1·44, 2·11, 1·88, 0·55}}$$

The body tapers towards the head end (plate VI, fig. 4) which is rounded and somewhat flattened dorso-ventrally. The oral orifice is terminal, and has no appendages. The oesophagus is straight, has no bulb, measures 0·5 mm. in length. The anal orifice is not quite central terminally, but is situated a little towards the ventral surface. The tail end (plate VI, fig. 5) is slightly curved and flattened. The vaginal orifice is at 0·42 mm. from the anterior end. The vagina and uterine tubes resemble those of filariae previously described. The egg measures 46·6 μ by 33 μ. The length of the embryo 315 μ.

The male is unknown.

The *embryo* in fresh blood specimens are very long, roughly measured to be about 360 μ; it has very active lashing movements, but only slowly progressive. It has no sheath; the contents are somewhat coarsely granular; the head end is rounded, has no papilla nor spine; the tail end tapers gradually to a very fine point.

In stained specimens (plate VI, fig. 2) the length averages 235 μ, breadth 6·4 μ. There is a very slight transverse striation of the somewhat thick cuticle. The head end shews no baying in the column of cells, which here ends abruptly.

Four 'spots' can be observed—all of which are constant:—

1. A narrow slit; distance 22·0 per cent. of the length of the worm from anterior end.
2. A bright oval lateral bay; distance 29·3.
3. A long portion in the middle of the worm in which the cell nuclei are few in number and stain less distinctly than the rest of the worm. Its middle point is at a distance of 61·7. This is characteristic of the worm.
4. A lateral bay, similar to and on the same side as the second; distance 84·9.

SPECIES OF FILARIAE, THE EMBRYOS OF WHICH WERE FOUND, BUT NO ADULTS

Filaria serpentiformis

Definitive host: *Cinnyris fuliginosa.*

F. falciformis also occurred in the blood of this bird. The embryos were found in small numbers in the blood; but many were present in the lung juice, while only a very occasional one was seen in preparations of heart's blood.

In fresh specimens (plate XIV, fig. 8) the embryos measured 436 μ; breadth 6·2 μ. They were very active, quickly coiling and uncoiling: only slightly progressive. The head end had no papilla nor spine, only a clear conical tip. Body contents granular, no distinctive spots. The tail end tapered gradually for about one-sixth of the length of the worm to a very fine point.

In stained specimens (plate XII, fig. 1) the length was 339 μ. Head end, which is slightly tapered, is round, and for a distance of about 10 μ from the tip shews no nuclear staining. A single narrow band-like or **V**-shaped spot only, at a distance 19·9 per cent. of total length of the worm from the anterior end can be made out. At the junction of the posterior and middle thirds is an indefinite area in which the stained nuclei are looser. The tail end consists of a single column of cells gradually diminishing in size.

This embryo resembles somewhat that of *F. shekletoni*, but it is much longer both in stained and fresh specimens and the arrangement of the 'spots' serves to distinguish them.

Filaria opebensis. Nov. Sp.

Definitive hosts: *Hyphantornis aurantus.*
Hyphantornis. Sp. incert.

Stained specimens only obtained (plate XII, fig. 2). The length of the embryo varies considerably both in specimens of blood from different birds and in

specimens from the same bird. Average 43 μ (37·5 to 61 μ). Breadth 6·6 μ. The nuclei which are very small, stain very deeply. At the head end the column of nuclei breaks into two lines to form a 'bay.' The tail end tapers in the last sixth to about one-half of its width, and then terminates in a small bulbous end. There is a very thin cuticle.

'Spots.' These can be distinctly made out, only one is constant.

1. A small irregular transverse slit, at distance 25 per cent. of length of the worm.
2. A slight lateral bay at 33·8.
3. A band across the worm at distance 60·0. This is the constant spot and a characteristic of stained specimens of this embryo.

Filaria calabarensis. Nov. Sp.

Definitive host not yet identified.

The embryos were found in central and peripheral blood. In some blood specimens (plate XII, fig. 3) these embryos occurred alone; in others, from other birds, they occurred with *F. bibulbosa* and *F. falciformis*. They were present in five birds out of nine examined. Stained specimens only available for description. Length 163 μ; breadth 4 μ. No sheath, but the thin cuticle shows very slight striation.

The anterior extremity is rounded, and there is a 'bay'-shaped opening in the column of cells, which is thus bifid. The uniform width of the worm is maintained up to the position of the third 'spot' described below, where the worm begins to taper to a very fine point.

The following 'spots' are observed:—

1. A small anterior central irregular 'spot,' distance 24·2 per cent. of length from the anterior end.
2. A shallow lateral 'bay,' at 34·6.
3. The largest and most distinct of the 'spots,' roughly diamond-shaped, at 60·8.
4. A lateral break, occurring at the same side as the second, at 82·8.

A FILARIA, THE ADULT MALE OF WHICH ALONE WAS FOUND; FEMALE AND EMBRYOS NOT OBSERVED

Filaria phoenicopteri. Nov. Sp.

Definitive host: *African Flamingo.*

The Flamingo had been skinned and cut into pieces before the time of our examination. Five male worms were found under the skin and on the muscle fascia; the examination of the available blood showed the absence of embryos.

The length of the worms averaged 13·4 mm., breadth 0·26 mm.

$$\text{Cobb's formula : } \frac{\text{—, } 2{\cdot}67,\ 13{\cdot}3,\ 50,\ 99{\cdot}6}{\text{—, } 1{\cdot}87,\ 2{\cdot}40,\ 2{\cdot}13,\ 1{\cdot}06}$$

The cuticle is thick, transparent, ridged, is thinner at the anterior end of the worm. The head end (plate XI, fig. 4) tapers somewhat to 0·25 mm. ; there is a slight indication of a neck 0·25 mm. across. Over the position of the buccal orifice, which is terminal and central, there is a slight flattening on the edge of which are four small tubercles. The oesophagus is very long, and marked off by a constriction from the intestinal tract, which is seen to course down the worm, curving from side to side to end at the anus a little in front of the extreme tip of the tail. The tail end (plate XI, fig. 5) tapers for a considerable distance, and is incurved. The extreme end is bluntly rounded. The anal orifice is wide, placed on a slightly raised papilla ; through the orifice in some specimens, the tip, in others about 50 μ length of a single sharply pointed spicule, projects.

The worms are too opaque for further details to be made out.

IV. HUMAN FILARIASIS

The species of the genus *Filaria* which are supposed to give rise to haematozoal embryos found in human blood are:—

1. *Filaria bancrofti*, COBBOLD; syn. *F. sanguinis hominis*, LEWIS; *F. nocturna*, MANSON.
2. *Filaria diurna*, MANSON.
3. *Filaria perstans*, MANSON.
4. *Filaria demarquaii*, MANSON.
5. *Filaria ozzardi*, MANSON.
6. *Filaria magalhäesi*, MANSON.
7. *Filaria loa*, GUYOT.

Filaria bancrofti

Historical. The embryo of this parasite was discovered by DEMARQUAY in 1863 in the chylous fluid from a case of dropsy of the tunica vaginalis, who came originally from Havana. WUCHERER, in 1866, found the embryos in the urine of several cases of tropical chyluria. In 1868 and following years, LEWIS, SALISBURY, CREVAUX, and COBBOLD observed the parasite in similar cases in or from Calcutta, the United States, Gaudaloupe, and Port Natal. In 1872 the history of the discovery of the life of this parasite entered a new phase, when LEWIS found that the embryos had their normal habitat in the blood of man. DA SILVA LIMA, CREVAUX, and MANSON established the identity of these blood filariae with those occurring in cases of chyluria and lymph scrotum in Brazil, the Antilles, and in China. In 1876 BANCROFT found an adult worm in an abscess in a lymphatic gland in the arm, and later four others in a hydrocele of the spermatic cord. Since then DA SILVA ARANJO, LEWIS, MANSON, and others have found adult worms in different sites. MANSON, studying the disease in China, observed a periodicity in the occurrence of the embryos of the parasite in the peripheral blood, and deduced therefrom the function of some blood sucking insect to play the part of intermediary host. In 1879 he demonstrated the life history of the parasite in the body of the mosquito, *Culex ciliaris*. As to how the parasite reached man again from the body of the mosquito several theories were advanced, until Low, in 1900, in sectioning some of MANSON's specimens of infected mosquitoes, observed the filariae in the proboscis: which discovery naturally leads to the inference that they are introduced at the time of puncture of the skin by the mosquito.

Description. The adult *Filaria bancrofti* is a long, hair-like, transparent nematode, three or four inches in length. Males and females often are found

together; sometimes there are found several in a bunch in cyst-like dilatations of the lymphatic vessels, sometimes they inhabit the larger lymphatic vessels. The female is the larger, both in length and thickness. The length varies from 88 to 155 mm., the breadth from 0·6 to 0·7 mm. We have been unable to obtain COBB's formula for this worm. The body is plain, tapering towards the rounded head end rather abruptly to a neck, which is about one-third the width of the body; beyond which it is enlarged somewhat. The cuticle is finely striated. The mouth is terminal, simple, 4 μ in width. The tail end tapers and ends bluntly. The anus opens on the ventral surface at a distance of 0·13 mm. to 0·28 (according to the size of the specimen) from the posterior extremity, on the summit of a projection which resembles a bilobed papilla. At the extremity of the tail the cuticle presents a small depression, surrounded by two small lips. The vulva is situated at a distance of 1·26 mm. to 2·56 mm. (according to the size of the specimen) from the anterior end. The worm is ovi-viviparous. The ova measure 25 μ to 38 μ by 15 μ.

The male has a length of about 83 mm., breadth 0·407 mm. The body is cylindrical, tapering gradually from the anterior to the posterior end. The tail is vine-tendril like, the extreme end being sharply incurvating, making one or two spirals. The cuticle is delicately striated transversely. The anterior end is rounded, and not marked off by a neck from the rest of the body. The mouth is circular, simple, and terminal. The cloaca opens on the ventral surface at 0·11 mm. from the extremity. The tail end presents four pairs of pre-anal and four pairs of post-anal papillae, having a wide base. The oesophagus has a thick muscular wall, which gives it the appearance of a pharyngeal bulb: it is 0·99 mm. long, and is well marked off from the intestine. The genital tube is single. The cloaca gives exit to two unequal spicules.

The *embryos* measures from 270 to 340 μ long by 7 to 11 μ wide.

MANSON[1] describes the parasite and its movements thus:—'In fresh blood, *F. nocturna* is seen to be a minute, transparent, colourless, snake-like organism which, without materially changing its position on the slide, wriggles about in a state of great activity, constantly agitating and displacing the corpuscles in its neighbourhood. At first the movements are so active that the anatomical features of the filaria cannot be made out. In the course of a few hours the movement slows down, and then one can see that the little worm is shaped like a snake or an eel—that is to say, it is a long, slender, cylindrical organism, having one extremity abruptly rounded off, the other for about one-fifth of its entire length gradually tapering to a fine point. . . . When examined with the low power, it appears to be structureless; with a high power, a certain amount of structure can, on close scrutiny, be made out. In the first place, it can be seen that the entire animal is enclosed in an exceedingly delicate, limp, structureless sack, in which it moves backwards and forwards. This sack or "sheath"

1. Manson, *Tropical Diseases*, London, 1900; p. 485.

as it is generally called, although closely applied to the body, is considerably longer than the worm it encloses, so that that part of the sack which for the time being is not occupied is collapsed, and trails after the head or tail or both, as the case may be. It can be seen also that about the posterior part of the middle third of the parasite there is what appears to be an irregular aggregation of granular matter which, by suitable staining, can be shown to be a viscous of some sort. This organ runs for some distance along the axis of the worm. Further, if higher power be used, a closely set, very delicate transverse striation can be detected in the musculo-cutaneous layer throughout the entire length of the animal. Besides this if carefully looked for at a point about one-fifth of the entire length of the organism backwards from the head end, a shining triangular V-shaped patch is always visible. What may be this V-spot is brought out by very light staining with dilute logwood. The dye brings out yet another spot, similar to the preceding, though very much smaller; this second spot is situated a short distance from the end of the tail. The former I have designated the V-spot; the latter, the "tail spot." . . . Staining with logwood also shows that the body of the little animal is principally composed of a column of closely packed, exceedingly minute cells enclosed in the transversely striated musculo. cutaneous cylinder; at all events, many nuclei are thereby rendered visible. Dr. Low has recently pointed out to me that the break seen in all stained specimens in the central column of nuclei occurs at a point slightly posterior to the anterior V-spot. This break can only be recognized in stained specimens. When the movements of the living filaria have almost ceased, by careful focussing it can be seen that the head end is constantly being covered and uncovered by a six-tipped or hooked and very delicate prepuce; and, moreover, one can sometimes see a short fang of extreme tenuity suddenly shot out from the uncovered extreme cephalic end and as suddenly retracted.'

In the above description in all its details, our observations of the embryos occurring in cases in Nigeria completely agree; but we think that the movements of the embryos in fresh microscopical preparations previous to the stage at which the anterior tip of the 'sheath' of the worm appears to become attached to the glass, have been overlooked. If preparations be made and examined directly, it will be seen that the embryos, for a short period only, exhibit a rapidly progressive movement across the field—so rapid at first that they can only with some difficulty be traced. This movement quickly ceases, the sheath of the embryo apparently becoming attached by its tip as described.

In stained specimens in our collection we have been able to distinguish the following spots, and their positions are indicated in a manner similar to that already used in describing the embryos of avian filariae—namely in percentages of the total length from the anterior end. The measurements have been made on a number of embryos, the percentages having been found to agree very closely in each. The average total length in stained specimens was 180·2 μ.

1. An irregular transverse break, at about 21·5 per cent. of length. This is constant.
2. A V-shaped spot or a transverse irregular break at a distance of about 30 per cent. of the whole length from the anterior end. This is nearly always present.
3. Represents the central aggregation of fresh specimens: an area of varying length in which the cells are loosely arranged—distance 63. The point from which measurements were made was the middle point of this area. This is constant.
4. An irregular sometimes oval spot, often present at distance 85.
5. A small central bright spot, only occasional present at distance 91·5.

We propose here, before referring to the singular feature in the life of the embryo filaria known as 'filarial periodicity,' to describe briefly *F. diurna*.

Filaria diurna

MANSON[1] writes of this worm:—'I have twice encountered in negroes a blood worm with the same dimensions and anatomical characters, so far as these have been made out, as *F. nocturna*, but differing from this latter parasite, inasmuch as it comes into the blood during the day and disappears from it during the night. One of these patients came from Old Calabar, the other from the Congo. The periodicity observed by the parasite was thoroughly made out by prolonged observation in one of the cases. As the man was in good health at the time, and was observing ordinary habits as regards the hours of sleeping and waking, there can be little doubt that the parasite was not *F. nocturna*. Some years previously this patient had a *F. loa* in one of his eyes; it is just possible, therefore, that *F. diurna*, as I name this blood worm, is the embryonic form of the sexually mature *F. loa*. This is merely a conjecture. I have no further observations to support it; indeed, the negative results as far as finding filariae in the blood in four cases of *F. loa* which I have examined, are against it. Nothing is known about its life history or pathological significance. From recent observations I believe it to be very common (1 in 4) in certain districts on the lower Niger, where it seems to take the place among the natives that *F. perstans* holds among the Congo negroes.'

Our observations of a large number of cases of infection of what would be described as *F. diurna*, among natives from all parts of the west coast of Africa, verify the description of the blood filaria as given above by MANSON. In fact, absolutely no difference could be detected between this embryo and that of *F. nocturna*, either in fresh or in stained specimens. In stained specimens the characters and positions of the spots resemble closely those of *F. nocturna*.

1. Manson, *Tropical Diseases*. London, 1900. P. 532.

Filaria perstans.

The embryos of this worm are present in the peripheral blood both day and night. The parent forms have been described by DANIELLS, who found them in the connective tissues at the root of the mesentery, behind the abdominal aorta and beneath the pericardium. The male is smaller than the female. The body is smooth and devoid of markings.

DANIELLS[1] describes these worms, and compares their lengths and breadths with those of the adult forms of *F. bancrofti* and *F. magalhäesi*, thus:—

	F. bancrofti	*F. magalhäesi*	*F. perstans*
Length of female	95 mm.	155 mm.	70 to 80 mm.
Thickness „	0.2	0·66	0·12
Length of male	44	8	45
Thickness „	0·10	0·25	0·06

The neck is longer than in *F. bancrofti*: the mouth is very minute; no differentiation of the alimentary canal into oesophagus and intestine could be made out. The female tail curves for the last 0·3 to 0·4 mm. Anus 0·145 mm. from the tip of tail. The tip of the tail is 'mitred.' The embryos *in utero* are blunt-tailed, not sheathed.

The male is like the female with regard to the head end. Two perfect caudal ends were found. They were very much coiled, and had one spicule and two papillae.

The embryos measure on an average 200 μ long by 4·6 μ broad: but their dimensions vary over considerable range, the embryos possessing to a remarkable degree the power to elongate and shorten. They have no sheath. The body tapers gradually for two-thirds of its length towards the tail end which is truncated and abruptly rounded. On examination of the head with the high powers of the microscope, a fang is generally observed, in constant play, protruded and retracted. No prepuce is to be made out. The movements of the embryos are extremely active, in very fresh preparations it is is almost impossible to follow them as they rapidly wriggle about between the corpuscles. Progressive movement continues for many hours.

In stained specimens the embryos of our collection on an average measure 89 μ. Four spots can be made out:—

1. A narrow irregular transverse band at distance 26·4 per cent. of total length from anterior end. Nearly always present.
2. A wider irregular transverse spot at a distance 36. Only occasionally present.
3. The largest of the spots, but not always present; an irregular transverse area at 63·2.
4. A very inconstant central bright speck at 83·2 distance.

1. Daniells, *British Medical Journal*, 1898, vol. I, p. 1011.

In the blood of one native, a court messenger at Degema, we found on very many occasions an embryo similar to that of *F. perstans* in its movements, general shape, and appearance, but longer (average in stained specimens 151 μ). Four spots in stained specimens were made out, and were more distinctly marked than in the case of the ordinary *F. perstans.*

1. A constant narrow transverse band at a distance of 24·2 per cent. of total length from the anterior end.
2. A small lateral bay at distance 32·4. Fairly constant.
3. A distinct small area, in which the cells are loosely arranged, at distance of 61·2. This is only occasional present.
4. A small bright spot, sometimes lateral, sometimes central, at 81·2.

Filaria demarquail

The embryo only of this worm is known. It is thus described by MANSON[1] who observed it in specimens of blood from natives of St. Vincent, West Indies, in 10 out of 150 examined. 'It resembles *F. nocturna* and *F. diurna* so far as shape is concerned, but differs from them in size. I have had no opportunity of making trustworthy measurements of living specimens in suitably prepared slides, but judging from rough preparations, *F. demarquaii* appears to be rather more than half the size of *F. nocturna* and *F. diurna.* It is sharp-tailed, like these, but in addition to the size it differs from them inasmuch as it observes no periodicity, being present in the peripheral circulation both by day and by night, and, also, in not being enclosed in a sheath. Nothing is known of its life history, minute anatomy, or pathological bearings. Possibly it is the embryonic form of *F. magalhäesi*—also a tropical American blood parasite. I have recently met with apparently the same parasite in the blood of natives of St. Lucia, West Indies, where DR. GALGEY has still more recently shewn that either it, or a similar blood-worm, is very common. It is quite possible that the sharp-tailed filaria *(F. ozzardi)* of British Guiana is the same species. I have also found a minute, non-sheathed, sharp-tailed embryo filaria in the blood of natives of New Guinea, likewise closely resembling *F. demarquaii.* Whether these various embryos belong to one or to several species it is impossible to decide until the parental forms of each have been discovered and compared.'

Filaria ozzardi

A single adult female and a portion of the male found in the subperitoneal tissues in the anterior abdominal wall of an aboriginal Demerara Indian by DANIELLS,[2] whose blood contained nematode embryos similar to those to which

1. Manson, *Tropical Diseases.* London, 1900. P. 533.
2. Daniells, *British Medical Journal,* June 17, 1899.

MANSON originally gave the name of *F. ozzardi*, are believed to be the parent forms of these embryos. DANIELLS compares the dimensions and characters of these adults with those of *F. bancrofti* and *F. perstans* ; the table we reproduce here :—

DESCRIPTION OF FILARIA OZZARDI EMBRYO

	F. bancrofti	*F. perstans*	*F. ozzardi*
	mm.	mm.	mm.
Length	85 to 90	70 to 80	81
Greatest thickness	0·20 to 0·26	0·120	0·210
Diameter of head	0·055	0·070	0·050
Diameter of neck	0·049	0·054	0·039
Distance from head—			
(1) Of vaginal outlet ...	0·710	0·600	0·710
(2) Of ovarian opening ...	0·920	?	0·850
Distance from tail of anal papilla ...	0·225	0·145	0·230
Termination of tail	Blunt, circular, not bulbous	Slightly bulbous : covered with thickened cuticle prolonged into two triangular appendages	Bulbous cuticle, not thickened

The *embryos*. We have been able to obtain only a very short and imperfect description of the embryo. OZZARD[1] and DANIELLS[2] described two embryos occurring in the blood of the aboriginal Indians of British Guiana—one a blunt-tailed worm, which has since been identified as *F. perstans;* the other, 'sharp-tailed, is about the size of *F. demarquaii* and similar in shape, but has no sheath.' No periodicity was observed in either case. 'The tail (of the sharp embryos) tapers slowly for a great length of the body to a fine and quite sharp point; the embryos arrange themselves often in figures of 8. The specimens are longer, and often in their thickest part broader than in the blunt tails. The arrangement of nuclei is clearer and more distinct, and the whole worm less deeply stained. The nuclei (of the tail end) are always arranged in single file for a considerable distance, and the terminal one has its long axis parallel to the long axis of the worm; while from this the body of the worm is continued for about 0·01 to 0·02 mm. to its termination free from nuclei. There are no nuclei at the cephalic extremity; the first ones seen are rod-shaped, with unstained spaces between, and at some little distance from the head is a gap (V-spot).

Filaria magalhaesi

The adult worms, which alone are known, are described by MAGALHAES[3] as having been found lying in the left ventricle of a child at Rio de Janeiro. The two

1. Ozzard, *British Guiana Med. Annual*, 1897.
2. Daniells *British Guiana Med. Annual*, 1898.
3. Magalhaes, *Rio des Cursos Theoricos e Prat da Fac. de Med. de Rio Janeiro*, No. 3, An. III, 1896.

worms found were sexually mature. No examination of the blood had been made. The worms were cylindrical, capillary, and opalescent, white, uniform in thickness except where the body tapered towards the tail and at the club-shaped oral end; the swollen oesophagus was well marked off from the intestine. The mouth was simple, circular and unarmed, the cuticle marked with fine transverse striations. The female measured 15·5 mm. long by 0·7 thick, the male 8·3 mm. long by 0·4 mm. thick. The vulva was 2·56 mm. from the head end, at a point which divided the length of the worm in the proportion of 1 : 59. The tale of the male possessed four pairs of pre-anal and four pairs of post-anal papillae and two spicules, 0·17 mm. long. The tail made one and a half to two spirals. Nothing is known of its life history.

Filaria loa. Guyot

This worm varies from 16 to 70 mm. in length, average 30 to 40.

The female of our collection measures 50·8 mm. in length, 0·57 mm. in breadth.

$$\text{Cobb's formula : } \frac{—, —, —, 5·0, 99·6}{—, —, —, 1·1, 0.39}$$

Description. The worm is of uniform thickness throughout the whole of its length, except at the head end where it sharply tapers, and at the tail where for some distance in front of its extremity, the worm gradually tapers to less than half its breadth. The cuticle bears a large number of small rounded bosses apparently irregularly arranged as also described by Manson[1] and others. The head end has the shape of a cone, with an abruptly flattened apex, at the centre of which is the small oral orifice : no buccal appendages are apparent. The specimen is too opaque for the oesophagus and its junction with the intestine to be made out. The vagina opens at a distance of 2·5 mm. from the anterior extremity. The tail end which tapers considerably, terminates in a short incurved portion (in our preserved specimen), on the concavity of which at a distance of 0·2 mm. from the extreme tip is seen the anal orifice at the summit of a low broad papilla. At the extreme end are two small fine tubercles. The ova, containing embryos, measure 35 μ by 25 μ; the embryos measure 210 μ long.

Descriptions of two male specimens are given by Manson.[1] 'Length, 25 to 30 mm., breadth, 0·30 mm. Thickness uniform except where it tapers at the head and tail. Mouth simple, no papillae nor armature. The tail end is sharply incurved and perhaps excavated ventrally; it is not spirally twisted. The tail is provided with well marked lateral alae. There are four well marked papillae on each side of the ventral surface of the tail. The three anterior papillae are pre-anal and large. They are closely approximated, stout and bulbous at the free end. The fourth is ad-anal or post-anal and is distinctly nearer the middle line and considerably

1. Manson, *Transactions of Ophthal. Soc.* London, 1895. *Case of Filaria loa*, by D. Argyll Robertson. Charles, *Sci. Mem. Medic. Officers, Army of India*; vol. vii., 1892, p. 51. Argyll Robertson, *Transactions of the Ophthalmological Society*. London, 1895. *Case of Filaria loa.*

smaller. The fifth is much smaller than the other, and is conical and sharp pointed. There are two slender, unequal spicules. The cuticle is not obviously straited but is dotted over with a number of widely scattered nearly hemispherical smooth bosses. No definite arrangement of these bosses could be made out. The large bosses are at the middle of the worm. The internal structure could not be made out.'

The *life history* of *F. loa* is quite unknown. MANSON suggests that it is the parent form of *F. diurna*.

Of the embryos, MANSON[1] says :—'The more mature embryos resemble in size and shape those of *F. nocturna* and *F. diurna*, but in consequence of the method of mounting it is impossible (speaking of the particular specimen under examination) to say if they are possessed of a sheath or not. If they are possessed of a sheath, I should say that they are practically indistinguishable from the parasites mentioned.' LEUCHART states that the embryos of *F. loa* 'are enclosed in thin egg shells, and bear a close resemblance to *F. sanguinis*, but are smaller (0·21 mm.)'

Our experience of the few cases of *F. loa* which we met with during the expedition accords with that of MANSON, in that an examination of the blood day and night did not reveal the presence of filaria embryos. We have, however, recently received a female specimen of *F. loa*, removed from the eye of a Kroo boy by Dr. A. H. HANLEY, medical officer at Opobo, Southern Nigeria. An examination of the blood showed the presence of embryos. We have counted the embryos on four slides taken at different hours of the day and night which were sent with the adult specimen.

At 10 a.m.	the blood preparation	contained	seven	embryos
„ 3 p.m.	„	„	„	nine	„
„ 9 p.m.	„	„	„	no	„
„ 11 p.m.	„	„	„	one	„

These figures point to an infection with *F. diurna*, but the examinations being so few, in the light of the results of examinations of other cases, a very definite opinion cannot be given.

Dr. HANLEY also sent a specimen of a male *F. loa* removed also from the eye of a Kroo boy whose blood contained no embryos. We were fortunate enough to obtain at Bonny a single female of this species for our collection, and on breaking the worm across after preservation in formalin, sheathed embryos very similar to those of *F. diurna* were extruded from the broken ends of the worm. These embryos, extruded by pressure from the body of the uterus of a formalin preserved specimen, measured 208·5 μ long on an average, and have a distinct sheath, in fact, they appear similar to the embryos of *F. nocturna*. In stained specimens they measure 199·6 μ long. (It must be noticed that these embryos had been fixed in the

1. Manson, *Trans. of Ophthalm. Soc.* London, 1895. *Case of Filaria loa*, by Argyll Robertson.

body of the uterus by the formalin in which they were preserved, whereas the embryos of *F. nocturna* described and measured were fixed in blood films by absolute alcohol).

The following 'spots' were made out :—

1. An oval or diamond shape central spot, at a distance of 24 per cent. of the length of the worm from the anterior end.
2. An indistinct lateral area containing scattered nuclei—distance 37·3.
3. A longer portion of the worm which stains badly, and in which the nuclei are irregularly scattered : sometimes it is divided into two portions, anterior and posterior. Because of the bad definition of this area, its position could not be ascertained exactly.
4. A small lateral bay, at a distance of 86·2.

Filaria nocturna, diurna and perstans.

Geographical distribution. HIRSCH[1] gives an interesting account of the distribution of elephantiasis throughout the world. 'In the Eastern Hemisphere the disease is endemic in many districts : the Southern regions of the Asiatic continents and islands, such as the coast of Arabia, many parts of India, Ceylon and the Malay Archipelago, some districts of further India and the Southern and South-Eastern coasts of China. In Syria and in Japan the disease is not so common. In India elephantiasis is specially frequent along the littoral of Lower Bengal ; along the littoral swamp of the Orissa. It is found also in Pondicherry and at a few places on the Coromandel Coast ; but most of all on the Malabar coast, especially in the districts of Travancore and Cochin. In the Deccan and in upper India it occurs much less frequently, although small endemic centres exist. In Ceylon the disease is common, more especially along the coast. In the East Indies, the Lampong district of Sumatra, Banka, the Nicobars, and the Phillipines, are the regions most severely affected ; the disease is less often seen in the other islands such as Java and Amboina. It occurs also in Penang and in Cochin China.

Certain of the islands of Polynesia are among the worst regions of the globe for elephantiasis: such as the northern part of New Caledonia, the Tonga, and Fiji groups, the Samoa group, Wallis Island, the Society Islands (especially Tahiti and Raiatea), and the Gambia group. It is less common in the Marquesas and in the Hawaiian Islands. In Australia as well as in New Zealand, it is not endemic. In Africa, Réunion and Mauritius, the Seychelles, Madagascar and Nossi-Bé, the Mozambique and Zanzibar coasts, the whole coast of Upper Guinea, including the Gaboon and Cameroons country, and the Benin Coast, Gold Coast, Spice Coast and Sierra Leone, as well as the Senegambia, the disease is endemic. In parts of Tunis, Algiers, and Egypt nearest the Mediterranean, and the swampy valleys of the interior

1. Hirsch, *Handbook of Geographical and Historical Pathology*. New Sydenham Society, 1886, vol. iii, q. 712.

of Abyssinia, the disease is met with. In the upper valley of the Nile (Nubia and the neighbouring countries of the negro) elephantiasis would seem to be unknown; on the other hand there are accounts of its endemic occurrence at some places in the Greater Soudan, such as Bornou, Segu Sicorro, and Ogooué. Under the same circumstances of locality we find the disease widely endemic in the Western Hemisphere: as in the coast regions of New Granada, Venezuela, and Peru; in those parts of Brazil that are mostly tropical in character. On the coast and marshy levels of Guiana; in many islands of the West Indies such as the Barbadoes, Martinique, Guadaloupe, Trinidad, St. Vincent, and St. Bartholomew; as well as on the Gulf Coast of the Central American States of Nicaragua, Costa Rica and Panama and of Mexico.

In Europe, in Greece it is very rarely met with; it has been more frequently seen in Turkey; in the south of France also, and in Lisbon and southern Spain it would appear to be relatively common; but the patients may be in great part such as have acquired elephantiasis in the East.'

As to the demonstration of the presence of *F. nocturna* in the inhabitants of these countries, search for the adults and the microscopical examination of the blood for embryos has not yet been very extensive; but in so far as observations go, the results roughly cover the same extensive distribution as that of elephantiasis. MANSON[1] has examined blood films from many parts of the world, including Old Calabar, the Lower Niger, Dahomey, Zanzibar, Mombasa, in Africa; Madras, Cochin, Ceylon in Asia; Samoa, Fiji, the Friendly Islands in Polynesia; Georgetown, New Amsterdam, and the littoral of Demarara in British Guiana; and the islands St. Vincent, St. Kitts and Montserrat, and Trinidad among the Islands of the West Indies.

Filaria diurna. As the presence of this blood parasite is not associated with any marked pathological lesion, the determination of its geographical distribution (necessitating the microscopical demonstration of the embryos in the blood, and of their characteristic diurnal periodicity), has not been so exactly nor so extensively made. In 1900, MANSON[2] states that he has twice encountered the embryos of *F. diurna*, once in a negro from Old Calabar, and another from the Congo; and further, that from recent observations, he believes it to be very common (one in four) in certain districts on the lower Niger. This short account seems to be the whole of the present knowledge of the distribution of the *F. diurna* throughout the whole world, excepting the discovery of what, we think, must be taken as *F. diurna* in the Friendly Islands by THORPE[3]; this will be referred to again later.

Filaria perstans. For similar reasons as in the case of *F. diurna*—the absence of apparent pathological lesions and of the necessity of frequent daily microscopical

1. Manson, *Tropical Diseases*, London, 1900, p. 483.
2. Manson, *Tropical Diseases*, London, 1900, p. 532.
3. Thorpe, *British Medical Journal*, 1896, vol. ii, p. 922.

examinations of the blood—the geographical distribution of this parasite is but little known. Until recently it was believed to be confined to Africa, MANSON[1] stating that 'this parasite is very common in the blood of natives of large districts in West Africa. I have found it in natives from Old Calabar and from the basin of the Congo, both in the coast natives and in those from the interior. DANIELLS informs us that he has found it in a native of British Central Africa residing on the East side of Lake Nyassa. In many parts of the endemic districts it occurred in about half of the population. Professor FIRKET, of Liege, has confirmed this observation as regards the Congo district. Sometimes it occurs along with *F. diurna* and *F. nocturna* in the same individual. I have never found it in West Indian negros, nor in fact, in natives of any country except West Tropical Africa, and in the aborigines of Demerara. I have twice found it in Europeans who had resided in the Congo.'

OZZARD[2] and DANIELLS[3] found many cases of *F. perstans* among the aboriginal Indians of Demerara—some 130 miles up the Demerara River, and also up the Berbice River. DANIELLS also discovered the adult forms of the worms among the aborigines of British Guiana.

OBSERVATIONS ON THE DISTRIBUTION OF THE BLOOD EMBRYOS AMONG WEST AFRICAN NATIVES

We had opportunities, during the sojourn of the expedition in Nigeria, of examining the blood of natives from all parts of the West Coast of Africa, from Sierra Leone at its Western extremity, as far as the Old Calabar district at the Eastern, and from the coast inland as far as the region of the kingdom of Sokoto some 500 miles in the northern direction, and as far as Yola on the Benue river easterly. Throughout the whole of this vast area, the natives appear to be infected with *F. nocturna*, *diurna* and *perstans:* and there can be no doubt that the distribution of these parasites will prove to be much more extensive in Africa, and probably throughout the tropical world, than is at present supposed. The native Kroo boys whom we examined both day and night, generally remain in a certain place for a period varying from a few months to a number of years, usually having left their native districts after reaching manhood, returning thither at intervals. As a large number of the others examined were prisoners, these had often remained the greater part of their lives in their own countries, and had been transported to the towns at which we met them, for confinement for political, criminal, and other offences.

From our notes of cases we have made the following table, illustrating the number of cases of pure and mixed infection throughout the district mentioned above. In the table, N.D. and P. represent *F. nocturna*, *diurna*, and *perstans* respectively; N.D., N.P., D.P., represent a double infection with *F. nocturna* and *diurna*, *nocturna*

1. Manson, *Tropical Diseases*. London, 1900. P. 536.
2. Ozzard, *British Guiana Medical Annual*, 1897.
3. Daniells, *British Guiana Medical Annual*, 1898.

and *perstans*, and *diurna* and *perstans* respectively, while N.D.P. indicates the triple infection. The diagnosis of the nature of the infection is based on the examination of the blood at twelve mid-day and twelve midnight, and a case was judged to be one of *F. nocturna* or *F. diurna*, according to the presence of the larger number of filariae at one or the other time; where the numbers were close the infection was noted as a mixed *nocturna* and *diurna*, although we are aware that this may not have represented the actual state of infection, as will be seen below in the paragraph on 'periodicity.'

TABLE I.

	No. examined	No. infected with						
		N.	D.	P.	N.D.	N.P.	D.P.	N.D.P.
NATIVES OF :—								
Southern Nigeria, including the Old Calabar and Cross River districts; Bonny, Opobo and New Calabar districts; Akwete district; Brass, Wari, Sapele and Benin River districts, and the Lower Niger district extending as far as Idah ...	135	7	19	16	7	2	2	1
Northern Nigeria, including Lokoja and the regions of Sokoto, Kano, and the Benue River district	22	3	2	2	1	1	...	...
Lagos and hinterland	6	...	2	...	...	...	...	...
Gold and Ivory Coasts	4	1	...	1	...	...	...	1
Kroo Coast	40	3	1	1	2	...	1	1
Other districts, including Sierra Leone; and a few natives whose native country was not ascertained ...	18	—	1	3	—	1	—	—
TOTALS ...	225	14	25	23	10	4	3	3

The following table shows the percentage of infected natives in towns having different sanitary conditions; for example Group I contains a number of towns and villages situated chiefly near the mangrove swamp, which are usually in a deplorable filthy condition; the natives of this group were found to be infected with haematozoal embryos to the extent of 50 per cent.; whilst Group II contains comparatively clean up-country towns in the region beyond the mangrove swamp. Group III are large coast towns.

TABLE II

	Number examined	N.	D.	P.	N.D.	N.P	D.P.	N.D.P.	Number Infected
GROUP I									
Old Calabar...	35	...	8	9	1	...	1	...	19
Bonny	11	...	1	...	1	...	...	...	2
Brass	11	...	...	4	...	...	...	...	4
Okrika	4	1	2	...	1	...	...	...	4
Opobo	5	2	1	...	...	...	...	...	3
Bugama	5	...	1	1	1	...	...	...	3
Degama Town	8	1	1	...	1	1	...	...	4
New Calabar	5	2	1	...	...	...	...	...	3
Abo...	4	1	1	...	...	...	...	...	2
	88	7	16	14	5	1	1	...	44
GROUP II									
Lokoja	5	...	...	...	1	...	...	...	1
Abonnema	4	...	...	...	...	...	...	...	0
Akwete	3	...	...	...	...	...	...	...	0
Azumine	2	...	...	...	...	...	...	...	0
Obuzo	2	...	1	...	...	...	...	...	1
Abutshi	4	...	...	...	...	...	...	...	0
Idah...	2	1	...	...	...	...	...	...	1
	22	1	1	...	1	...	...	...	3
GROUP III									
Cape Coast	3	1	...	1	...	...	...	...	2
Lagos	5	...	1	...	...	...	...	...	1
S. Leone	7	...	1	...	...	...	...	...	1
Accra	1	...	...	...	...	...	...	1	1
	16	1	2	1	...	...	...	1	5

Periodicity

In the case of *F. nocturna* MANSON and others have been able on several occasions to demonstrate a 'periodicity' in the life of the blood embryo. MANSON[1] thus describes the phenomenon:—'If under ordinary conditions of health and habit, the blood of a patient be examined during the day, the parasite is *rarely* seen, *or, if it be seen only one or two specimens at most* are encountered in a slide. It would be found, however, that as evening approaches, commencing about five or six o'clock, the filariae begin to enter the peripheral circulation in gradually increasing numbers. The swarm goes on increasing until about midnight, at which time it is no unusual thing to find as many as three hundred, or even six hundred, in every drop of blood. . . . . After midnight the numbers begin gradually to decrease; by eight or nine o'clock in the morning the filariae have disappeared from the peripheral blood for the day. This diurnal periodicity is, under normal conditions, maintained with the utmost regularity for years. Should, however, as MACKENZIE has shown, a filarial patient be made to sleep during the day and remain awake at night, the periodicity is reversed; that is to say, the parasites come into the blood during the day and disappear from it during the night. It cannot be the sleeping state, as some have conjectured, that brings about this periodicity; for the ingress of the filariae into the peripheral blood commences three or four hours before the usual time for sleep, and the egress several hours before sleep is concluded, and this egress is not complete until several hours after the usual time of waking. . . . . A recent opportunity has enabled me to ascertain that, during their diurnal temporary absence from the cutaneous circulation, the filariae retire principally to the larger arteries and to the lungs, where, during the day they may be found in enormous numbers.'

To illustrate this phenomenon of periodicity we give the following table re-constructed from data given by MANSON.[2]

1. Manson, *Tropical Diseases*. London, 1900. P. 489.
2. Manson, *The Filaria Sanguinis Hominis*. London, 1883.

TABLE III

No. of Filariae per drop of finger blood

	Date	A.M.									P.M.											
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Case 1.	10 viii. 79	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17	...	...	...	...
	11 „	...	...	...	...	0	...	...	...	...	...	0	...	...	...	...	...	16	...	...	...	...
	12 „	...	...	...	...	...	0	...	...	...	...	0	...	...	...	...	...	26	...	...	...	...
	13 „	...	...	...	...	0	...	...	...	...	...	0	...	...	...	...	...	14	...	...	...	...
	14 „	...	...	...	...	2	...	...	...	...	...	...	...	2	...	...	...	6	...	...	...	...
	15 „	...	...	...	...	...	0	...	...	...	...	0	...	...	...	...	...	4	...	...	...	...
	16 „	...	...	...	...	...	0	...	...	...	...	...	0	...	...	...	...	...	26	...	...	...
	17 „	...	...	...	...	...	2	...	...	...	...	0	...	...	...	...	...	...	12	...	...	...
Case 2.	15 vii. 79	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13	...	...	...
	10 viii. 79	...	...	...	...	1	...	...	...	...	...	...	...	0	...	...	...	25	...	...	...	...
	11 „	...	...	...	2	...	...	...	...	...	...	0	...	...	...	...	...	...	...	...	...	...
	12 „	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...
Case 3.	16 vi. 79	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	43	...	...	...	...
	17 „	6	...	...	...	2	...	...	...	1	...	...	...	0	...	...	...	24	...	...	...	57
	18 „	23	...	...	...	1	...	...	...	0	...	...	...	0	...	...	...	105	...	...	...	21
	19 „	18	...	...	...	0	...	...	...	0	...	...	...	0	...	1	10	29	37	...	...	...
	20 „	15	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	29	...	...	...	89
	21 „	2	...	...	...	1	...	...	...	0	...	...	...	1	...	...	...	53	...	...	...	41
	22 „	2	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	17	...	...	...	34
	23 „	5	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	24	...	...	...	43
	24 „	23	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	14	...	...	...	...
	25 „	7	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	10	...	...	...	13
	26 „	14	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	19	...	...	...	...
	27 „	11	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	10	...	...	...	...
	28 „	5	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	12	...	...	...	...
	29 „	17	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	13	...	...	...	...
	30 „	14	...	...	...	0	...	...	...	0	...	...	...	0	...	...	...	12	...	...	...	35
	1 vii. 79	33	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Case 4.	20 viii. 79	...	...	...	...	1	...	...	...	...	...	...	...	0	...	...	...	5	...	...	...	...
	21 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	0	...	...	...	...
	22 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	1	...	...	...	...
	23 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	0	...	...	...	...
	24 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	2	...	...	...	...
	25 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	12	...	...	...	...
	26 „	...	...	...	...	0	...	...	...	...	...	...	...	0	...	...	...	2	...	...	...	...
	27 „	...	...	...	...	1	...	...	...	...	...	...	...	0	...	...	...	0	...	...	...	...

Table IV, showing experimental inversion of filarial periodicity constructed from MANSON's Chart.—No. of filariae in preparation under 1 x 1½ inch cover glass.

DATE	A.M.						P.M.					
	2	4	6	8	10	12	2	4	6	8	10	12
9. xii. 79	...	...	...	...	...	...	...	...	0	...	58	...
10 „	...	...	63	...	0	0	...	...	0	...	62	...
11 „	...	...	96	...	6	0	...	0	10	...	30	...
12 „	...	...	155	...	8	0	...	0	8	...	88	...
13 „	...	...	70	...	6	0	...	0	8	...	26	...
14 „	...	...	48	...	7	0	...	...	0	...	38	115
15* „	...	...	185	...	12	6	...	...	0	...	8	12
16* „	...	...	52	...	46	8	...	...	6	...	8	28
17* „	...	38	8	...	70	14	...	...	6	...	8	6
18* „	...	8	48	...	38	60	...	...	5	...	5	8
19* „	...	5	74	...	76	50	...	88	5	...	4	6
20* „	...	8	38	...	62	52	...	...	10	...	2	8
21* „	...	15	42	...	36	34	...	...	11	...	10	11
22* „	...	11	28	...	60	46	...	...	10	...	6	6
23* „	...	15	54	...	48	95	...	...	24	...	8	4
24* „	...	12	21	...	68	86	...	...	18	...	8	8
25 „	...	9	15	...	...	...	...	...	...	...	...	...

We have had to construct this table from a chart in which the number of filariae were recorded by dots placed between horizontal lines, each representing ten filariae, and thus the numbers may not be exactly correct (within one to five units), owing to the difficulty of gauging the number represented by a dot placed between such lines.

On days marked thus * the sleeping hours were from five a.m. to five p.m. On other days from six p.m. to six a.m. On December 14 the patient was not allowed to sleep. The experiment had been previously made by MACKENZIE[1] with similar results.

1. Mackenzie, *Trans. Path. Soc. of London*, vol. xxxiii, p. 400.

The following tables illustrating the periodicity of *F. nocturna* have been constructed from our own notes of a number of cases among West African natives. Three specimens were made from each case every three hours. Sufficient blood was taken, to form as nearly as possible a complete film under a cover glass three-quarter inch square, and the specimens were examined in the fresh condition. Throughout the following tables the maximum number of filariae in three slides is indicated by a larger type of figure.

TABLE V

Name	Date	Number of Filariae in three slides at							
		A.M.				P.M.			
		3	6	9	12	3	6	9	12
1. Oparobo ...	11. vii. 00 ...	20	0	0	0	0	10	**48**	26
2. Deafman ...	12. vii. 00 ...	0	2	0	0	0	0	1	**3**
3. James ...	12. vii. 00 ...	7	0	1	0	0	0	**11**	9
4. Abraham ...	27. viii. 00 ...	0	1	0	1	0	0	**4**	2
5. Onye mensoh	27. viii. 00 ...	18	2	0	0	0	25	45	**56**
6. Sumanu ...	27. viii. 00 ...	7	0	0	0	0	17	**21**	9
7. Osadebe ...	27. viii. 00 ...	28	2	1	0	0	35	34	**50**
8. Eyamah ...	27. viii. 00 ...	2	0	0	0	0	3	7	**19**

As to the periodicity of *F. diurna*, Manson[1] says simply that the parasites come into the blood during the day and disappear from it during the night; and, the periodicity observed by the parasite was thoroughly made out by prolonged observation in one of the cases. Actual records we have not been able to find.

From our own collection of records of cases we have constructed the following table illustrating the periodicity of *F. diurna* : the figures represent the number of embryos in three specimens of blood under a three-quarter inch square cover glass.

1. Manson, *Tropical Diseases*, London, 1900. P. 532.

TABLE VI

Name	Date	No. of Filariae in three specimens at							
		A.M.				P.M.			
		3	6	9	12	3	6	9	12
1. Robert ...	12. vii. 00 ...	0	8	84	58	66	47	0	0
2. Adeyemi ...	27. viii. 00 ...	0	3	8	48	7	3	0	0
3. Obudu ...	27. viii. 00 ...	0	10	21	32	...	8	1	0
4. Garuba ...	27. viii. 00 ...	0	1	27	52	38	9	0	0
5. Apanituen ...	20. vii. 00 ...	1	3	7	8	3	0	0	0

It has not been easy to pick out from our records a fair number of cases either of *F. nocturna* or *diurna* which may be said to be absolutely typical ; thus only eight cases of *F. nocturna* and only five of *diurna* could be found. We propose to call a case typical when the maximum number of embryos are present in the blood at mid-day or midnight as the case may be, or about those hours and when twelve hours later they are absent from peripheral blood.

The majority of the cases which we encountered on the West African coast were then atypical, in that, embryos were never absent from peripheral blood, or the maximum did not occur at mid-day and midnight or thereabouts according to the species. Among the former cases there were many shewing decided periodicity and among the latter, the hour at which the maximum number was present, varied considerably. In some cases two maxima during the twenty-four hours were indicated. Table VII shews a few cases in which though a decided periodicity is to be noted, embryos are never absent from peripheral blood.

TABLE VII

Name	Date	Number of Embryos in three specimens at							
		A.M.				P.M.			
		3	6	9	12	3	6	9	12
1. Davis ...	12. vii. 00 ...	12	61	425	478	197	252	12	9
2. Ajaca ...	27. viii. 00 ...	9	20	10	5	...	3	35	18
3. Arrigwe ...	3. vii. 00 ...	7	6	16	58	58	45	15	4
4. Ijululockia ...	20. vii. 00 ...	15	18	56	61	25	1	1	3

Table VIII gives a number of cases in which the maximum number did not occur at mid-day nor midnight.

TABLE VIII

Name	Date	Number of Embryos in three specimens at :							
		A.M.				P.M.			
		3	6	9	12	3	6	9	12
Etta	3. vii. 00 ...	12	3	8	20	**46**	25	21	21
Jumbo	3. vii. 00 ...	0	1	2	4	**18**	4	0	0
Efion	12. vi. 00 ...	0	11	7	5	**16**	6	0	0
Greenslade ...	12. vii. 00 ...	0	1	28	54	76	**81**	15	0
Glasgow ...	12. vii. 00 ...	4	**35**	...	9	20	**49**	3	0
Joe	12. vii. 00 ...	3	0	0	0	0	**4**	**12**	6
Oparobo ...	12. vi. 00 ...	20	0	0	0	0	10	**48**	26
Kelba	12 vii. 00 ...	2	1	0	3	5	8	**15**	7
James	12. vii. 00 ...	7	0	1	0	0	0	**11**	9
Abraham ...	27. viii. 00 ...	0	1	0	1	0	0	**4**	2
Sumana ...	27. viii. 00 ...	7	0	0	0	0	17	**21**	9
Ajaca	27. viii. 00 ...	9	20	10	5	...	3	**35**	18
Emordi... ...	27. viii. 00 ...	**54**	5	0	3	3	15	22	44
Arrigwe ...	12. vi. 00 ...	14	**25**	5	**27**	8	18	5	8
Mark	12. vi. 00 ...	2	**66**	28	22	...	18	2	1
Okohorsfall ...	20. vii. 00 ...	42	43	**54**	26	25	29	5	9
Deauma ...	20. vii. 00 ...	4	60	**130**	68	47	1	1	0
Robert	12. vii, 00 ...	0	8	**84**	58	66	47	0	0
Etim	12. vi. 00 ...	3	6	**16**	6	8	0	0	0

Thorpe[1] examined a number of natives of the Friendly Islands; but his results, as recorded in the article referred to, do not permit very definite conclusions. We have however reproduced them in the following tables copied from his article.

1. Thorpe, *British Medical Journal*, 1896, vol. ii, p. 922

TABLE IX

	Natives of Tongatabu			Natives of Normuka			Natives of Lifuka			Natives of Vavau			Totals		
	No. exam.	No. infect.	Per-centage	No. exam.	No. infect.	Per-centage	No. exam.	No. infect.	Per-centage	No. exam.	No. infect.	Per-centage	No. exam.	No. infect.	Per-centage
Males examined :															
Day and night ...	7	3	...	25	12	...	23	12	...	...	...	...	55	27	49
Day only... ...	3	0	...	3	0	...	2	1	...	...	...	...	8	1	...
Night only ...	31	11	...	9	3	...	6	5	...	14	4	...	60	23	...
	41	14	34·1	37	15	40·5	31	18	57	14	4	28 6	123	51	41·47
Females examined :															
Day and night ...	4	3	...	26	7	...	11	3	...	...	...	...	41	13	31·7
Day only... ...	3	0	...	6	0	...	...	...	...	...	...	...	9	0	...
Night only ...	17	2	...	11	1	...	7	2	...	6	0	...	41	5	...
	24	5	20·8	43	8	18·6	18	5	28	6	0	...	91	18	19·9
Totals for whole population ...	65	19	29·23	80	23	28.75	49	23	47	20	4	20	214	69	32·24

TABLE X

Name	A.M.			P.M.				
	9½	10	12	2½	5½	6½	8½	10
Tubon	...	21	9	16	17	...	30	...
Saen	22	...	27	...	...	16	...	...
Kesaia	...	80	...	...	...	...	...	56

The numbers represent the number of embryos in a drop of blood under a seven-eighths inch circular cover glass.

Referring to the day and night examinations, Thorpe says that no periodicity was observed: that the embryos resembled *F. nocturna;* they had a sheath, and exhibited the characteristic preputial collar and V-spots. He gives a number of measurements which correspond to those of *F. nocturna*, except that the worm appears to be a little smaller than that of China and India. In ninety-six cases examined, all

except two had an equal number of embryos in the blood both day and night: of the two exceptions, one showed a single parasite at night, none in the daytime; the other a single parasite at the day examination, none at night.

In spite of the small number of examinations and of their incompleteness, it is certainly evident from the above figures that the parasite does not agree in any way in its occurrence in the peripheral blood with either *F. diurna* or *F. nocturna*. It must however be noted that THORPE describes the Friendly Islands as 'a hot-bed of elephantiasis.' This point will be referred to later.

The following tables illustrate how the occurrence of embryos in the blood varies from day to day and week to week in the same cases. It must be here remarked, that the habits of the men whose blood was frequently examined for the purpose of the construction of these tables, were marked by extreme regularity. They were government prisoners, kept in the government prison at Bonny. The men rose at five o'clock, were fed at eleven o'clock mid-day, and were locked up in their cells about eight o'clock; from five till eleven and from twelve till six they were at work.

In every case three drops of blood were examined under a three-quarter inch square cover glass.

TABLE XI

Name	Date	Number of Filariae in three blood specimens at							
		A.M.				P.M.			
		3	6	9	12	3	6	9	12
1. Arrigwe ...	12. vi. 00 ...	14	25	5	27	8	18	5	8
	3. vii. 00 ...	7	6	16	58	58	45	15	4
	7 „ ...	...	...	...	18	...	...	...	...
	9 „ ...	...	...	...	...	38	...	...	...
	10 „ ...	...	...	...	...	43	...	...	...
	11 „ ...	...	...	...	...	89	...	...	...
	12 „ ...	...	...	...	...	13	...	...	...
	13 „ ...	...	...	...	...	32	...	...	...
	14 „ ...	...	...	...	...	53	...	...	...
2. Etta... ...	12. vi. 00 ...	46	50	27	26	24	6	5	17
	3. vii. 00 ...	12	3	8	20	46	25	21	21
	7 „ ...	...	...	...	...	17	...	...	...
	9 „ ...	...	...	...	...	4	...	...	...
	10 „ ...	...	...	...	...	10	...	...	...
	11 „ ...	...	...	...	...	17	...	...	...
	12 „ ...	...	...	...	...	14	...	...	...
	13 „ ...	...	...	...	...	9	...	...	...
	14 „ ...	...	...	...	...	9	...	...	...
3. Efion ...	12 vi. 00 ...	0	11	7	5	16	6	0	0
	3. vii. 00 ...	0	4	16	15	10	1	0	0
	9 „ ...	...	...	...	...	9	...	...	...
	10 „ ...	...	...	...	...	13	...	...	...
	11 „ ...	...	...	...	...	36	...	...	...
	12 „ ...	...	...	...	...	52	...	...	...
	13 „ ...	...	...	...	...	18	...	...	...
	14 „ ...	...	...	...	...	56	...	...	...
4. Jumbo ...	12. vi. 00 ...	1	4	8	1	4	0	0	0
	3. vii. 00 ...	0	4	16	15	10	1	0	0
	9 „ ...	...	...	...	...	10	...	...	...
	10 „ ...	...	...	...	...	0	...	...	...
	11 „ ...	...	...	...	...	2	...	...	...
	12 „ ...	...	...	...	...	2	...	...	...
	13 „ ...	...	...	...	...	7	...	...	...
	14 „ ...	...	...	...	...	6	...	...	...
5. Etim ...	12. vi. 00 ...	3	6	16	6	8	0	0	0
	3. vii. 00 ...	0	0	17	9	8	5	0	0
	9 „ ...	...	...	...	...	26	...	...	...
	10 „ ...	...	...	...	...	6	...	...	...
	11 „ ...	...	...	...	...	23	...	...	...
	12 „ ...	...	...	...	...	14	...	...	...
	13 „ ...	...	...	...	...	6	...	...	...
	14 „ ...	...	...	...	...	10	...	...	...

In this table the point to be noticed is that a considerable amount of variety occurs in the way in which embryos present themselves in the peripheral circulation in those cases in which the type *(F. nocturna* or *F. diurna)* is not strictly adhered to.

For instance, in Cases 3, 4, and 5, the numbers at each examination are as near as would be expected; but in Cases 1 and 2 the variations from day to day are considerable.

In the above tables, III to XI inclusive, a further feature is to be observed, namely, the variety in the severity of the filarial infection: thus, taking the numbers of embryos at the period when they reach a maximum in peripheral blood, it is seen that they are included between 3 and 480 in three specimens, or 1 and 160 per specimen of blood. It surely follows, then, that in some natives even when they are at their maximum number, in the peripheral blood, they may still be too few, *in toto*, to be observed in a single preparation of blood. Consequently, many more natives must be habitats for filariae than is supposed from the observation of peripheral blood in the usual way. When treating of *F. perstans* (see Table XII, Case 4), it will be seen that in some sixty preparations of the blood of one case, one filaria only was observed (possibly the infection with *F. perstans*, or the maturation of the parasite, may have occurred during the month under which the case was under observation). MANSON's[1] figures shew the same features in the cases of undoubted *F. nocturna* infection; but few of these figures, however, give the number of embryos per drop of blood when the largest number would have been present in peripheral blood, namely, twelve midnight: most of the specimens were made not later than ten p.m.: the figures range between 1 and 105. These facts must be taken to give some indication of the severity of the infection, of the number of adult females in the organism: since the results of observations extended over a long period—a month or more—shew no decided periods of increased fertility. But it surely must not be inferred from the relative numbers of embryos in the two extreme cases that the number of adult females in one case is a hundred or more times as many as in another, although it is difficult, at the present stage of our knowledge, to understand why such an inference should not be drawn. Referring to this subject, MANSON[2] is reported to have said—'If anyone is foolhardy enough to submit to be bitten by filariated mosquitoes, and if subsequently no young filariae be found in the blood, it must not be concluded from this that a mosquito bite is not the medium of infection. My belief is that before embryos can be found in the blood by ordinary miscroscopic observation large numbers of parent filariae must be present in the lymphatics. In many cases we know that hundreds of parent filariae are present. Thus in one case only two or three embryo filariae are found in each drop of blood; in other instances as many as 600 or more are found in a drop implying the presence of 300 times as many parental worms.' Although as above stated we do not at present understand why such an inference cannot be deduced, it is evidently not justifiable to make such an inference, judging from the number of infected inhabitants and the extent of their infection. We have not been

1. Manson, *The Filaria Sanguinis hominis*. London, 1883.
2. Manson, *Brit. Med. Journal*, Sept. 1. 1900. P. 536

able to find any record of a case or cases in which the embryos were regularly counted for a period shortly before death and in which, *post-mortem*, adults were found.

. . .... In the examination for malarial parasites[1] of blood specimens from a large number of native children of all ages up to about 18 years, we encountered a single filarial embryo only, in one case (specimens taken during the day were examined only)—aged 11 years, out of 390 cases. In view of the number of adults infected with *F. diurna* in the same districts, this is remarkable and further tends to support the idea that, the extent of infection increases during the period of childhood, until, when adult age is reached, there are a sufficient number of mature female filariae in the body to give an observable number of embryos in peripheral blood during the usual examination for microscopical purposes.

Under any other circumstances, it seems to us, there would be no chance of an escape from the continued and renewed infection of every individual. In a certain district, were such a number of embryos observable in the blood of every child—or even of a similar percentage of children, as is presented by the adults, every mosquito of the species capable of acting as intermediary hosts would become infected and in consequence every man, woman and child in that district would become infected to such an extent as to exhibit embryos in the peripheral blood. It thus seems that in this way nature has placed a limit to the prevalence of this infection.

Filaria perstans

But little need be said of the periodicity of this worm, which persists in the peripheral blood throughout the whole of the day. The following table illustrates the phenomenon.

1. *Report of the Liverpool Malaria Expedition to Nigeria.* Liverpool, 1901, part i, p. 11 *et seq.*

TABLE XII

Name	Date	A.M.				P.M.			
		3	6	9	12	3	6	9	12
1. Ekpeyon ...	12. vi. 00 ...	0	7	1	1	0	2	4	3
	3. vii. 00 ...	2	2	5	3	5	5	1	4
	9 „ ...	...	...	...	...	6	...	...	...
	10 „ ...	...	...	...	...	3	...	...	...
	11 „ ...	...	...	...	...	10	...	...	...
	12 „ ...	...	...	...	...	3	...	...	...
	13 „ ...	...	...	...	...	2	...	...	...
	14 „ ...	...	...	...	...	2	...	...	...
2. Etim ...	12. vi. 00 ...	1	1	0	0	0	0	4	1
	3. vii. 00 ...	2	2	1	1	0	4	4	1
	9 „ ...	...	...	...	...	1	...	...	...
	10 „ ...	...	...	...	...	2	...	...	...
	11 „ ...	...	...	...	...	2	...	...	...
	12 „ ...	...	...	...	...	1	...	...	...
	13 „ ...	...	...	...	...	0	...	...	...
	14 „ ...	...	...	...	...	10	...	...	...
3. Joe	12. vi. 00 ...	3	0	2	2	0	4	0	1
4. Efion ...	12 „ ...	0	0	0	0	0	0	0	0
	3. vii. 00 ...	0	0	0	0	0	0	0	0
	10 „ ...	...	...	...	...	0	...	...	...
	14 „ ...	...	...	...	...	1	...	...	...
5. Ijuluockia ...	19 „ ...	0	1	9	3	7	7	3	2
6. Demai ...	19 „ ...	1	0	2	2	0	0	1	0
7. Malam ...	27. viii. 00 ...	0	2	2	7	2	1	4	2
8. Obudu ...	27 „ ...	3	2	0	0	...	0	1	2
9. Sumanu ...	27 „ ...	1	1	0	0	0	0	4	1

The only striking feature which this table presents is the smallness of the number of *F. perstans* embryos; the greatest number we ever observed, was thirteen in three specimens under three-quarter inch square cover glasses; that is, approximately 2 to 3 c.mm. of blood.

The intermediary host of Filaria nocturna: its development.

The phenomenon of the periodicity of *F. nocturna* led Manson to induce the further development of the parasite in a blood-sucking insect of nocturnal habits. In 1878 Manson demonstrated developmental changes in the embryos after ingestion by the mosquito, since when the whole of the life history in the intermediary host has been observed by Bancroft, James, Sonsino, Low and ourselves in *Culex pipiens*, *C. ciliaris*, *C. fatigans*, *Anopheles costalis*, *Anopheles rossii*, Bancroft has shewn that *C. notoscriptus* (Skuse), *C. amuli rostris* (Skuse), *C. hispidosus* (Skuse) *C. vigilax* (Skuse), *C. nigrothorax* (Macquart), *C. procax* (Skuse) and *Anopheles musivus* (Skuse) do not serve as intermediary hosts.

Manson[1] gives the details of the various stages of the metamorphosis of *F. nocturna* embryos in *C. pipiens*.

First Stage. Transverse striation becomes well marked as if from a general longitudinally shrinking of the embryo; oral pouting vigorous. In about one hour the embryo casts its sheath; and then shows active locomotive movements. In from twelve to eighteen hours many have bored through the stomach wall of the mosquito and have reached the muscles of the thorax. Some die in the stomach. In the thorax, the striation disappears and movement ceases: the body becomes thicker and an illdefined cloudiness appears in the interior.

Second Stage. The body thickens, and there is a faint indication of a mouth; this stage requires two to three days for completion.

Third Stage. The anus appears, and cells are seen in the body; the mouth becomes open, and gradually four large fleshy lips are fashioned. The anus appears in front of the tail as a break or hole in the cuticle, from which granular matter exudes. The line of the cells, which are now visible in the previously apparently homogenous body, does not terminate at the anus but in advance of this, in some large prominent cells. The cells later become differentiated into an alimentary layer, and a tegumentary layer with a cavity between. The larva now measures $\frac{1}{800}$ to $\frac{1}{80}$ inch long (0·25 to 0·3 mm.) and $\frac{1}{850}$ to $\frac{1}{500}$ inch broad (0·048 to 0·45 mm.) There is considerable diversity in size and shape. The mouth is wide open; the tail is large and sickle shaped, and the cells of the body usually dip into it. The alimentary canal runs from mouth to anus. Motion is entirely suspended.

Fourth Stage. Growth is rapid: length $\frac{1}{70}$ to $\frac{1}{50}$ inch (0·35 to 0·5 mm.) The body retracts from the tail, which becomes a mere integumental appendage.

1. Manson, *Transactions of the Linnean Soc.*, 1884. P. 367

Fifth Stage: When the body has attained its maximum thickness, lengthening and thinning begin at the head end. The mouth inclines to purse up. The anterior and posterior ends may elongate simultaneously; more generally the process occurs throughout the whole length of the body of the larva. When the mouth closes, as it does later, all or nearly all trace of viscera and all traces of cells vanish. About the seventh day the body assumes a fibrous and very transparent appearance. Before this stage there can be made out a fully moveable alimentary canal, pharynx and oesophagus. Slight movements commence at the neck of the animal and extend downwards. MANSON thinks that about this stage a general ecdysis occurs, and the sickle shaped tail is cast off: a new skin can be seen covering the tail end, inside the sickle. Large cells appear at the end of the tail and form three or four papillae which characterise the larva at the end of this and during the next stage.

The worm has now reached a length of $\frac{1}{16}$ inch in length (1·5 mm.), its breadth has decreased to about one-half. The anterior end tapers and is abruptly rounded off; the posterior end also tapers slightly from the anus backward and is covered by the papillae just mentioned.

Sixth Stage. Movements become more active. The mouth is pursed up into a cone with lips firmly approximated; minute horny papillae are present. . . . The worm measures $\frac{1}{16}$ by $\frac{1}{850}$ inch (1·5 mm. by 0·03 mm.)

Up to 1900, this was supposed to be the complete development of the filaria in the mosquito, and at this stage it was conjectured that, on the death of the mosquito on the surface of the water, the young filaria escaped from the insect and swam about until it was taken up by man in drinking water.

In 1900 Low[1] in sectioning a number of filariated mosquitoes discovered a worm in the proboscis. He thus describes the transformation into the seventh stage:—'When the filariae have reached their highest stage of development in the thoracic muscles, they leave that tissue and travel forward in the direction of the head of the mosquito and pass into the loose cellular tissue which abounds in the prothorax near the salivary glands. Some struggle between the thorax and abdomen or within the abdomen itself. They then pass into the neck, enter the lower part of the head and coil themselves up in the loose connective tissue immediately below the cephalic ganglion and salivary sack. They pass into the proboscis by making an independent passage through the base of the labrum and pushing forward along the proboscis between the labrum and hypopharynx amongst the stilettes. Here they are found stretched along the length of the proboscis, head foremost. Two worms nearly always live together in the proboscis.'

JAMES[2] apparently was working at this subject at about the same time, and writes in an article, dated September, a description of the worms as seen in *Anopheles*

1. Low, *British Medical Journal*, 1900, June 16
2. James, *British Medical Journal*, 1900, vol. ii, Sept. 1, p. 535.

rossii on the seventeenth and eighteenth days of cultivation. 'The young filariae are found in the tissues of the thorax, in those of the head and neck, and in fewer numbers in those of the abdomen. The tissues of the head are examined by cutting through the neck. . . . . By carefully dissecting with needles the tissues of the head, and separating the parts of the proboscis, two or three filariae will almost invariably be found in this situation, and I have lately on two occasions found a filaria lying stretched out lengthwise partly within the tissues of the labrum of the proboscis, the remainder of its body being curled up in the tissues of the head. Without dissecting up the tissues of the labrum these filariae could be plainly seen with a $\frac{1}{6}$ inch objective through its fairly transparent tissue indulging in sinuous undulatory movements, and a very little manipulation with the needles sufficed to free the filariae when their movements changed from the snake-like undulatory character to the vigorous purposeless lashing and twisting which are characteristic of the final stage of the metamorphosis of the parasites in the mosquito. In the diagram I have shown the appearance of the filaria as it lies partly within the labrum. . . . . The young filariae in the final stage are from $\frac{1}{14}$ to $\frac{1}{16}$ of an inch in length, and $\frac{1}{800}$ inch in greatest breadth. It tapers towards the head and tail; the latter has three projections which can be spread out or drawn closely together in the animal's movements. The head end is rounded, and the mouth which is very extensile can be pushed out to form a little cone-like projection which sways from side to side, and is drawn in and pushed out as if searching for food. The filariae have an alimentary canal which at a somewhat earlier stage can be seen to be very freely moveable within the animal's body, and to be of varying shape in different parts of its course. Near the anus it is wide, and then narrows gradually to open at a short distance from the tail. On each side of the alimentary canal near the head, and again at a point about the middle of the body, the protoplasm is differentiated into other organs—probably reproductive.'

On August 4, 1900, as a result of some experiments which we had been carrying on as opportunities presented, during the time we were in Southern Nigeria, we were able to cable home that a living filaria had been found in the proboscis of *Anopheles costalis*. Previous to this several attempts had been made by us to cultivate both *F. nocturna* and *F. diurna* in mosquitoes of both genera, *Culex* and *Anopheles*, but without success. In this experiment with *F. nocturna* we were however successful. We had on several occasions previously noticed that large filariae were to be seen in the head of mosquitoes. The mosquitoes were fed on two occasions on blood containing embryos—July 18 and July 20, and in order to keep them alive for a period they had occasionally been fed on blood containing no embryos. On August 4 only five *Anopheles* of the batch remained, two of them being dead on the water. One of these on dissection proved negative. In the other, in the proboscis and near a trachea in the labium of that organ was a long thin filaria. In the thorax of this

mosquito a similar worm of the same size was found. A living mosquito was then taken, quickly killed by chloroform, and without any dissection whatever the thorax was pierced by a needle, and the finger nail placed on the tip of the proboscis. The parts were then gently drawn apart, the labium and palpi being thus separated from the stylets. A very active filaria was then seen to curl itself out from the neighbourhood of the trachea of the labium. This lived for about an hour in normal saline, coiling and uncoiling itself. The other two *Anopheles* died during the following night and on dissection proved to be negative.

In this stage, *the seventh*, the worm according to our specimen, is about 1·006 mm. long and 0·025 mm. broad. It tapers slightly to each end. At the anterior end, which is rounded off, the cuticle is thickened in places to form a few very small papillae disposed around the oral orifice, which is terminal. The posterior end, which is also rounded off, is provided with four papillae which are almost at right angles to the axis of the body of the worm. The position of the anal orifice cannot be definitely decided. The alimentary canal can be seen to run straight down the worm and shows no differentiation as far as we have been able to ascertain in oesophagus and intestine. Besides the alimentary tube in parts two other tubes can be seen which are for the most part straight, but at one or two points seem to twist round the intestine. Towards the head end at a distance of 0·14 mm. from the anterior end, there is an indication of the presence of an orifice towards which the reproductive tube is seen to bend.

Filariae in Anopheles costalis

According to our notes 281 *Anopheles* were examined for filariae—sixteen of these (5·7 per cent.) were found to contain the worms. The following are the details of the examinations :—

1. Two large filariae.
2. Eight to ten among thoracic muscles.
3. Several young larvae.
4. About ten large forms in thorax.
5. Several large forms among the thoracic muscles.
6. A single large filaria.
7. A small larva dissected out from the head.
8. Eight small larvae in thorax.
9. A few young forms in thorax.
10. Four young larvae.
11. Ten larvae found.
12. Fourteen larvae in thorax.
13. Several large larvae.
14. A single larva.
15. A single large larva found at the base of the proboscis.
16. Ten filariae in thorax.

The Anatomy of the Mouth parts of the Female Anopheles Costalis

The discovery of the final stage of the metamorphosis of the larval stage of *F. nocturna* in sections of the proboscis of mosquitoes, by Low,[1] in 1900; the observations of JAMES[2] as to the way in which the matured larvae tend to travel through the tissues of the head and neck into the proboscis; the work of GRASSI[3] on *F. immitis* in the dog, and in *Anopheles claviger*, in which the larvae were found in the labium; and our own researches in West Africa on the life history of *F. nocturna* in the body of *Anopheles costalis*; make a knowledge of the minute anatomy of the proboscis of the mosquito requisite for an exact understanding of how the larva leaves the insect and is transmitted to man.

As far as we have been able to ascertain very little has been done by entomologists in this country in the investigation of the histology of the proboscis of the mosquito; it has chiefly been examined from a morphological point of view, as of importance in the classification of species.

METHODS OF INVESTIGATION EMPLOYED

1. Examination of the proboscis of living insects.

2. Dissection of specimens in the fresh condition; and the examination of the organ hardened in alcohol and cleared in oil of cloves, and mounted as a whole or in parts in Canada Balsam.

3. By sections. Mosquitoes were killed by chloroform vapour; hardened in absolute alcohol for one or two hours, and embedded in paraffin. Serial sections (6 to 10 μ thick) of the proboscis and head were cut in three directions. Thin paraffin sections of the proboscis are with difficulty fixed to a slide by the ordinary methods of laboratory practice; the chitinous skeleton tending to break away from the delicate tissues which it encloses, in the processes of the manipulation of paraffin sections, so that minute anatomical relations become disturbed and obscured.

By the use of a slight modification of OBREGIA'S[4] method for fixing sections cut in paraffin, we were able to secure excellent results. A mixture of two parts of commercial liquid glucose and one part of a thick syrup of pure dextrin* is spread in a thin layer on to the glass slide by means of a glass rod. The serial paraffin sections as they are cut are laid directly on this layer on the slides, which are then placed in an incubator at about 40° c. for some hours, until the glucose mixture has dried hard. The paraffin is then removed by means of xylol and the slide with the sections is passed through absolute alcohol. A solution of photoxylin is then poured over the slide, so as to form a thin film over the sections; this layer of photoxylin is

1. Low, *British Medical Journal*, 1900. June 16.
2. James, *British Medical Journal*, 1900. Vol. ii, Sept. 1, p. 535.
3. Grassi, *British Medical Journal*, Nov. 3, 1900.
4. Obregia, *Neurologisches Centralblatt*, 1890.
   Gulland, *Journal of Pathology*, Feb. 1893, p. 391.

* 16 oz. dextrin; 17½ oz. water; 15 grains thymol.

allowed to set until the edges of the film begin to crinkle. On placing the slide in water, the film comes away with the sections which are now ready for staining *in situ* in the film. Carbol-xylol must be used for clearing after dehydration.

Most of our observations were made on *Anopheles costalis*, but a few specimens of *Anopheles maculipennis* and of different species of *Culex* have also been examined by dissection.

External anatomy of mouth parts

The term 'proboscis' is used to designate such of the mouth parts of *Diptera*, which taken together form their more or less flexible, shorter or longer, sucking apparatus. In the Culicidae the proboscis is a long slender organ arising from the lower projecting portion of the front of the head, beneath the clypeus or face. On its ventral surface it is continuous with the under surface of the head—the gulo-mental region. Its upper surface is sharply marked off from the clypeus by a deep groove. In a transverse section of the head at the base of the proboscis, (plate XVI, fig. 2) the latter appears to arise from a U-shaped mass under the clypeus, the upper parts of the arms of the U representing the genae or cheeks—narrow areas of the head situated in front of the eyes. The proboscis measures as a rule about three or four times the length of the head; in *Anopheles costalis*, 2 mm.

Parts constituting the proboscis

The proboscis consists of the upper lip—the labrum; the epipharynx; these two being firmly united together; the hypopharynx or tongue; two mandibles and two maxillae, which are commonly known as the stylets or setae, consisting almost entirely of transparent chitin, and used to pierce the skin; and the labium, or lower lip, the largest and fleshy part of the proboscis, in a groove on the upper surface of which the other parts are ensheathed when in repose. On either side and above the labium are the two maxillary palps, rod-like organs, covered with hairs and scales, and which, in *Anopheles*, lie above and parallel to the other mouth parts, and extend almost to the tip of the proboscis.

The general arrangement of the mouth parts to one another is seen in plate XV, fig. 3, a transverse section about the middle of the proboscis.

The epipharynx. The central tube through which the blood is sucked is formed by the epipharynx, which is morphologically the continuation of the upper and lateral chitinous walls of the pharynx. This tube is tunnel-shaped, being flattened on its under surface; its distal open end is oval, and looks ventrally—a fact first pointed out by Swammerdamm[1] in 1668. The wall of the epipharynx on the ventral surface becomes exceedingly thin, and fails to meet in the middle line, so that a slit is formed running the whole length of the epipharynx. The tip of the epipharynx ends

1. Swammerdamm, *Buch der Natur*. Leipzic, 1752.

in a sharp point, and presents the appearance of the point of a pen, having a central split and small eye. It is composed of two conical pieces, the bases of which blend with the upper rounded wall of the tube—and a slight thickening at the junction of the two pieces in the middle line gives rise to the appearance of the slit of the pen. On each side of the epipharynx, at its base, and intimately blend with it, is a stout rod of chitin having a core of large nucleated cells; this rod is the continuation of the lateral horizontal plate of chitin which at the base of the epipharynx affords attachment to the epipharyngeal muscles. The outer edge of it turns gradually upwards and inwards, and, fusing with the lateral convex surface of the epipharynx, forms the lateral supporting rod of chitin described. In transverse sections the core of nucleated cells in its interior is seen to be continued down the whole length of the epipharynx and at its distal end, the core turns upwards and towards the middle line; the epipharynx thus forming the extreme tip. The labrum, which is intimately blended with the epipharynx superiorly, thus takes no part in the formation of the extremity, stopping short before the nib-like tip is reached.

The interior of the epipharynx measures at its base, dorso-ventrally 19·8 μ, from side to side 26 μ; at the middle of the proboscis 16·5 μ dorso-ventrally, 18·1 μ across; and at the middle of the labellae 13·5 μ vertically by 13·2 μ across.

The **labrum** or upper lip is a delicate chitinous process situated immediately above the epipharynx and intimately connected with it, in fact it can be only partially separated from it by such reagents as caustic potash. For this reason DIMMOCK[1] described them as one piece—the labrum-epipharynx. The labrum arises at the base of the clypeus and runs along the upper surface of the epipharynx. In a transverse section near the base of the proboscis (plate XVI, fig. 1), it is seen that the labrum is composed of a curved lamella of chitin with its convexity approximated to the convexity of the upper surface of the epipharynx. The sides of the superimposed furrow thus formed, lower down the proboscis, suddenly become thinned, and, turning outwards and downwards are thrown into folds of very delicate chitin which unite below with the outer edges of the lateral rods of chitin of the epipharynx (plate XVI, fig. 1), the space thus closed in is occupied by loose cellular very delicate connective tissue. Towards its distal end, the furrow of the labrum becomes shallower and opens out, and the labrum itself becomes more intimately fused with the epipharynx. In sections (plate XV, fig. 1) near the tip of the proboscis the labrum-epipharynx is seen as a more or less triangular-shaped piece made up of three parts; two lateral pieces of chitin, in the centre of each of which is a deeply stained nucleus (chitin-cell); and a superimposed crescentic central upper piece united with the lateral portions by a very delicate band of tissue; this represents the tip of the labrum, which, as has been already described, stops short of the end of the epipharynx.

1. Dimmock, *The anatomy of the mouth parts and of the sucking apparatus of some Diptera.* Boston, 1881. P. 13.

At the proximal end the chitinous lamella of the labrum ends within the clypeus, projecting upwards for a considerable distance as a flattened rod-shaped piece, which affords attachment to fan-shaped muscles, arising from the roof of the clypeus.

The hypopharynx. Savigny (1816); lingua, Westwood; ligula, Kirby and Spence (1828); or tongue, is formed by a prolongation of the chitinous lower wall of the pharynx. It is a thin, flattened lamella of chitin, closely applied to the under surface of the labrum-epipharynx. Its lateral edges are turned upwards slightly, and upon these rest the inner edges of the mandibles and the convex basal borders of the epipharynx. The tip of the hypopharynx is simple and lanceolate. In the centre of the hypopharynx the chitin is thickened and deeply hollowed out on its upper surface, to form an almost completely closed gutter running down the whole length of the organ, and approximated to the slit on the under surface of the epipharynx. The hypopharynx consists of an upper thick flattened plate of chitin, hollowed at its centre to form the gutter, and a lower thin plate; the intermediate space being filled with delicate connective tissue, and is lined with chitin forming cells: well seen in a section at the base of the proboscis (plate XVI, fig. 1). Throughout the distal two-thirds the two plates are fused together, the space remaining as a core of cells, imbedded in the chitin on each side of the salivary gutter. This gutter commences as a **V**-shaped opening (plate XIX, fig. 1) at the point of origin of the hypopharynx. Connected with this aperture is the salivary receptacle (plate XVIII, fig. 1 *s.r*), a hollow, cone-shaped organ, lying applied to the ventral wall of the pharynx. The base of the cone points backward and slightly upwards; the apex, after a slight curve upwards, opens on to the salivary gutter at the **V**-shaped slit. The sides of the receptacle are of thick opaque chitin, except on its dorsal surface, which is somewhat flattened and composed of thin membranous transparent chitin. The lateral walls of the receptacle are strengthened by chitinous bands from the lateral portions of the clypeus. The base of the receptacle is distinctly membranous in character, very faintly staining with haematein: a little below its centre the common duct of the salivary glands is inserted. Above and around the insertion of the duct are attached the fine tendons of two muscles, one from each side (plate XVIII, fig. 1 *f.m.* and XIX, fig. 1 *r.m.*). These muscles arise together from the ventral surface of the lower chitinous plate of the pharynx, but more especially from a chitinous ridge on each side, which is concave anteriorly and also from above down, and projects from its under surface near the junction of the first and second portions of the pharynx (plate XVIII, fig. 1), The mechanism of the receptacle is probably as follows:—When the muscles contract, dilatation of the cavity of the receptacle is produced by pulling of the membranous base outwards; saliva then flows in and fills the cavity. On relaxation of the muscles, the membrane springs back into its original position, thus expelling the saliva down the channel of the hypopharynx.

The mandibles, two in number, are extremely delicate, transparent scroll-like rods of chitin, applied, one on each side of the base and sides of the epipharynx,

they are concave on their inner and convex on their outer surfaces, and are of uniform thickness for the greater part of their length, but for a short distance above their sharply-pointed tips they broaden, become more lance shaped and are twisted once upon themselves. In a transverse section at this level, they present several concavities into which the sides of the labrum-epipharynx, hypopharynx and maxillae fit (plate XV, fig. 1). Near their termination on the outer convex surfaces, lying along the upper edge is a row of very fine sharply pointed teeth varying in number, the sharp points projecting downwards. DIMMOCK[1] does not describe these teeth-like processes as occurring in the three species of *Culex* on which his observations were made. With regard to the origin of the mandibles DIMMOCK[2] says 'at the base of the proboscis they appear to have no muscular attachment but to lie embedded in the connective tissue beneath the pharynx and above the maxillae.'

In *Anopheles costalis*, plate XVI, fig. 2 shews their close relation to the inner surface of the base of the maxillary palpi, as a straight piece of chitin enclosing delicate cellular tissue. In sections further back they are difficult to trace but appear to come into relation with a downward projecting plate of chitin about the level of the anterior edge of the gena. They would thus appear to arise from chitin in the close neighbourhood of the groove between the clypeus and the gena. By tearing away the parts of the proboscis by traction at the tip with the finger nail, the mandibles come away with the maxillae attached to the maxillary palpi. To the base of each mandible a muscle is attached by a fine tendon ; the muscle arises from the ventral surface of that part of the chitinous exoskeleton of the head, which is folded inwards beneath the eyes ; the fibres are directed forward and slightly downwards.

The maxillae are two stouter lancet-shaped processes of chitin, one on each side ; concave on their inner surface and fitting beneath the sides of the mandibles and the hypopharynx. On the upper and inner surface a slight distance from its inner edge runs a stout ridge of chitin from which the thinner portion of the maxilla curves upwards and outwards. The stout ridge is continued to the distal end of the maxilla, forming the sharp point. Some little distance from the point of the maxilla the thinner portion begins suddenly to shade off like the sharp edge of a penknife ; this surface bears on its ventral side near the outer edge fifteen to twenty low conical chitinous papillae. DIMMOCK[3] refers to them as being on the dorsal surface in *Culex*, and says 'they are true papillae, not points of a serrate edge.' The thinner portion of the shaft of the maxilla is marked with alternate light and dark bands at right angles to its longitudinal chitinous rod ; this is due to the fine corrugation of its surface pointed out by DIMMOCK.[4] This appearance is not

1. Dimmock, *The Anatomy of the Mouth parts, etc., of some Diptera.* Boston, 1881.
2. Dimmock, *Loco-cit*, p. 16.
3. Dimmock, *Loco cit.*, p. 17.
4. Dimmock, *Loco cit.*, p. 16.

present on that portion of the maxilla from which the papillae arise. In a transverse section of the maxillae near their tips they present a peculiar jaw-like shape (plate XV, fig. 1). The maxillae appear to arise from the under surface of the maxillary palpi between them and the upper outer surface of the labium; in transverse sections they appear in this region as two lateral sickle-shaped stout masses of chitin, situated on each side of the commencement of the hypopharynx (plate XVI, fig. 2). Each maxillae is continuous with a thick rod of chitin, which extends almost the whole length of the head, ending in a long upper and a lower shorter stumpy rounded process in the basal part of the occipital region. To these intercranial chitinous rods, which appear to lie free in the cellular tissue at the base of the head, powerful muscles connected with the movements of the proboscis are attached (plate XIX, fig. 1; XVII, fig. 1; and XVIII, fig. 1). These processes have been variously termed; by LOWNE,[1] 'apodémes;' by MACLOSKIE,[2] the 'great tendons' of the mandibles. GERSTFELDT[3] regarded them as the basal portions or 'cardines' of the hypopharynx. No mention is made of them by PACKARD[4] in his description of the insects' mouth parts. SMITH[5] regards these basal processes found in various genera of diptera *Bombylius*, *Anthrax*, *Eristalis*, *Musca*, etc., as basal prolongations of the palpifers (the mandibles of other authors), and states they may perhaps represent the 'stipides' as well—which he has not as yet identified in the dipterous mouth parts. It would seem from DIMMOCK's[6] account of the anatomy of *Culex* that these chitinous rods do not extend so far back into the head in this genus; he says 'their continuations (of the maxilla) in the head are two delicate chitinous supports, each of which ends in a strong muscle; this muscle—the retractor maxillae—passes backwards and downwards through the head beneath the infra-oesophageal ganglion, and has its origin in the posterior basal part of the head.' That they are the supports from which the maxillae arise can be well seen in serial sections.

The muscles in connection with the chitinous intra-cranial processes of the maxillae are:—

1. Muscles fixing them to the cranial exoskeleton. Each has a large muscle which arises from the lower occipital region of the cranium and is attached to the outer side of the process for the greater part of its extent: the fibres of this muscle run horizontally; muscle fibres, directed upwards, also run in connection with the terminal bifid extremity and that portion of the exoskeleton of the head, which is folded beneath the eyes (plate XIX, fig. 1 *z.m.*).
2. A spindle-shaped belly of muscle arises from the ventral surfaces of the processes to be inserted into the base of the labium (plate XVII, fig. 1; XIX, fig. 1 *l.m'*).

1. Lowne, *The Anatomy and Physiology of the Blow-fly*. London, 1870.
2. Macloskie, *The Proboscis of the House-fly*. American Naturalist, 1880, vol. xiv, p. 153.
3. Gerstfeldt, *Ueber die Mundtheile der saugenden Insecten*. Dorpat, 1853.
4. Packard, *Text-book of Entomology*. New York, 1898.
5. Smith, *Trans. American Entom. Soc.*, vol. 17, 1890, p. 338.
6. Dimmock, *The Anatomy of the Mouth parts, etc.* Boston, 1881. P. 16.

3. Muscle fibres arise from the superior surfaces of these processes, from a short length at their distal ends, and are directed upwards and forwards to be inserted into the upper surface of the first joint of the maxillary palpi.

Though the stylets appear to be wholly of chitinous structure yet in transverse section at their point of origin (plate XVI, fig. 1) it is seen that they really consist of a central prolongation of the delicate tissue lining the head, encased in a thick chitinous envelope under which is a row of flattened cells with large deeply staining nuclei ; these cells which secrete chitin can be traced almost to the tips of the labrum-epipharynx and hypopharynx. In the maxillae and mandibles traces of these chitin cells are seen in sections near the tips as a central staining core. (Plate XV, fig. 1 and 2). It is to be remarked how the shape of the stylets serve to bind them together, the convexity of the one above fitting into the concavity of the one below ; thus forming a solid chitinous awl with which the skin is pierced. A section at the tip of the proboscis illustrates the fitting of the stylets with one another (plate XV, fig. 1). In fact if the tip of the proboscis be cut off a little above the labellae, the stylets fall out of their labial sheath as one piece, nor do they separate unless pressure be applied. A good view is obtained in this way of the saw-like edges of the mandibles and maxillae, the latter being below and to the outside of the former.

The maxillary palpi. In *Anopheles*, the maxillary palpi are two long segmented rounded processes, thickly covered with hair and scales, lying in the resting condition,one on either side, on the upper surface of the labium and its enclosed stylets ; their tips are rounded off and end a little short of the tip of the proboscis. They are attached to the side of the head below on either side of the clypeus, their under surfaces here being in close relation to the maxillae (plate XVI, fig. 2). The basal joint is bulged on its upper surface ; on its under surface the chitin is thickened to form a ridge, which is in close relation at its proximal end to the chitinous prolongation of the maxillae. This joint contains muscle fibres arising from the maxillary prolongation ('great tendon') near its union with the maxilla, which are directed obliquely upwards and forwards to be inserted into the bulged upper surface.

Each palpi contain delicate connective tissue containing large cells : a nerve, comparatively large, arising from the lateral surface of the infra-oesophageal ganglion, and numerous very small tracheae. Muscle fibres are only present in the basal joint. The study of the maxillary palpi with regard to shape, size and surface markings is of great importance in the classification of species.

The labium or lower lip is the largest of the mouth parts and acts as a sheath for the stylets. It commences as a free piece in the same plane as the other mouth parts and is a continuation of the lower anterior part of the head below the pharynx. On its under convex surface it is marked off from the ventral surface of the head by

a slight groove which continues upwards on either side for a short distance, becoming deeper. Its convex ventral and lateral chitinous surfaces are thickly covered with hairs and scales, the chitin bearing them having irregular annular markings. Its upper surface is of smooth chitin, upon which the stylets rest. The labium tapers slightly from base to apex: at its commencement it is broad from side to side, its internal measurement from above down being 45·6 μ; from side to side 65·2 μ; its smallest depth is 22·8 μ and width 42·4 μ. Its upper smooth surface is here flattened and on it rest centrally the hypopharynx, on either side the two maxillae (plate XVI, fig. 2). A little way from its origin, the labium becomes roughly round in shape owing to the edges of the upper surface turning upwards and inwards over the stylets forming a large oval channel in which they lie (plate XV, fig. 3); these edges are extremely fine and do not meet in the middle line, so that a space of uniform width is left running along the dorsal surface of the labium to its extreme tip. At about 0·16 mm. from the extremity of the proboscis the labium proper ends abruptly, while its upper concave surface is continued on to the tip of the proboscis, gradually tapering to a blunt point covered with fine hairs. This tip of the labium is easily broken off in dissections of the proboscis.

At the abrupt ending of the main portion of the body of the labium, which in transverse section is somewhat oval from side to side, are attached by true joints two lobiform appendages—the labellae—which enclose between their inner surfaces the tips of the stylets and the true tip of the labium. Crescentic at their bases, the labellae gradually taper to form the tip of the proboscis.

Running longitudinally on each side of the labium, and projecting into its substance from the inner surface of the chitinous exoskeleton, is a thick, very opaque chitinous ridge. These ridges commence at the base of the labium, and end abruptly a little distance behind the point of attachment of the labellae (plate XIX, fig. 3); from their inferior surfaces for about 34·3 μ from their distal extremities, and extending obliquely downwards and upwards, the chitin of the convex under surface of the labium proper becomes greatly thickened, forming two ventral plates, which in the mid-ventral line curve upwards and outwards, scrollwise, into the substance of the labium, ending in a short thick rod, near the centre of each lateral half of the labium (plate XIX, fig. 3 *r*). They present four borders: a proximal convex border continuous with the general exoskeleton of the labium; an outer border limited by the lateral longitudinal ridges of the labium; an inner, ending abruptly in its substance as a thick ridge of chitin; and a lower distal border, convex, curving from within, outwards, and upwards towards the distal end of the lateral ridge of the labium: upon the thickened inner extremity of this surface, which is hollowed out for its reception, the labella articulates. The labellae being removed, a view of the termination of the labium seen in section (plate XV, fig. 2) presents the following regions: on either side a pear or kidney-shaped area, approximated below in the median line to its fellow; to these areas the bases of

the labellae are applied. Above and resting between these areas is the concave tip of the labium (seen as a concave band of chitin in section), on which the stylets rest: these three parts enclose a roughly triangular area covered by a delicate membrane, thrown into folds, and extending above along the under surface of the tip of the labium, fusing with its sides and tip; on either side being in connection with the bases of the labellae and with the joint. This membrane bears a few very fine hairs, and it probably allows of considerable play when the labellae are separated; with them it touches the skin when the mosquito sucks blood, being then stretched to some extent.

The labellae are conical and roughly crescent-shaped in section; their apices form the extreme tip of the proboscis. They present two surfaces, an outer convex, an inner concave; and two borders an upper and a lower, the former being in the same line as the edges of the upper surface of the labium.

In some species of *Culex* and in *Anopheles maculipennis* they consist of two parts, a distal, and a basal upon which the distal half is jointed to allow of some outward movement; the joint being represented by a narrow white line beginning near the apex on the outer surface at its upper border and curving sharply downwards and outwards to the lower border; about the centre of this line is a sharp upward bend. This peculiar division of the labella is absent in *Anopheles costalis*. SMITH[1] who points out the homology of the so-called labium of the *Diptera* with the galea of other insects, states with regard to its tip in five species of *Culex* he examined 'no two agreed in structure.' We have found this to be the case also in a few species of mosquitoes we have examined, especially with regard to the structure of the joint at the base of the labella.

The outer surfaces of the labellae are covered with fine hairs and here and there coarser ones. The inner concave surfaces are marked by longitudinally ridges and folds. There are no 'pseudo-tracheae.' In transverse section (plate XV, fig. 1), three regions are distinguished; an upper somewhat flattened, the chitin of which is very thin and thrown into numerous small folds from which arise a felt work of exceedingly fine long hairs, crossing one another in all directions; a lower area of fairly thick chitin limited by the rounded inferior border of the labella: from it arises long thick bristle-like hairs projecting downwards in between the tips of the labellae. These two areas, well marked near the tips of the labellae, gradually fade away towards their bases. Between them, the central region is deeply hollowed out and ridged and folded, its chitin is much thicker and free from hairs. A little below its centre, running longitudinally down this surface is a stout ridge of chitin which can be traced in a cleared specimen of the labium, mounted whole, to the base of the labella (plate XIX, fig. 3): here it makes an outward curve to about the centre of the

1. Smith, *Trans. American Entomol. Soc.*, vol. xvii, 1890, p. 330.

base, and turning sharply back, turns upwards for a short distance to terminate in a rounded knob, which articulates with the chitinous surface described at the distal end of the labium. To the outer bend of this rod the tendon of the muscle of the labella is attached. When these muscles contract, the labellae are drawn apart and rotated in such a way that their inner surfaces look downwards: it is probable that only the anterior distal portion of their inner sufaces is applied to the skin.

The internal structure of the labium. In a section of the proboscis about its middle (plate XV, fig. 1) it is seen that the chitinous exoskeleton of the labium is lined with a delicate spongy tissue containing very large rosette-shaped cells—a continuation of a similar tissue lining the cranium. Beneath the chitinous envelope, here and there, is a row of low cubical epithelial cells (hypodermis). Situated about the centre of the section are the two labial tracheae, one on each side side, each surrounded by a delicate cellular sheath; with each runs a comparatively large nerve-trunk—the nerves to the proboscis. The tracheae are the terminal branches of the large tracheae to the head; they join the nerves to the proboscis immediately after their origin from the suboesophageal ganglion: on their way down the labium they give off small lateral branches and becoming smaller, eventually break up into innumerable fine branches about the lower third of the labium to supply the labellae. The nerves, two in number, are the main anterior branches of the suboesophageal ganglion. Running on either side of the common salivary duct they enter the labium beneath the salivary receptacle on the under and outer side of the tracheae, being closely applied to them: after a straight course they split up in the labellae into many fine fibres which are distributed over their inner surfaces.

Internal structure of the labellae. Applied to the outer wall and bulging into the interior of each labella, almost completely filling it is a mass of deeply staining tissue which, with a high power, is seen to be composed of numerous cells very similar in shape and size to the nerve cells of the supra- and infra-oesophageal ganglia of the head. Over the surface of this densely cellular mass, the nerve to the proboscis ends by splitting up into fine filaments (plate XIX, fig. 2). The close relation of the nerve to the proboscis to this structure, points to its being ganglionic in nature, probably supplying the numerous sensory hairs on the inner surface of the labellae with nerve fibres. These ganglia are well supplied with very fine tracheae, the terminal branches of the tracheae to the proboscis.

Muscles of the labium are of two sets:—

Those attached to the base of the labium.

Those arising within the labium.

The latter—the muscles of the labellae—are two long slender paired muscles, each arising by numerous separate bundles of fibres from the dorsal and ventral surfaces of the lateral chitinous ridges of the labium; they are directed very

obliquely towards the tip of the proboscis. These bellies of muscle end in minute tendons which join a very long common tendon, running parallel to the chitinous ridges and extending the whole length of origin of the muscle. These long tendons do not quite reach the mid-line of the labium (plate XIX, fig. 2, *l.m'*); becoming somewhat thicker, they are eventually inserted into the bases of the labellae, chiefly at the chitinous angle mentioned above. These muscles do not appear to take origin from the basal third of the chitinous ridges of the labium. DIMMOCK[1] describes in *Culex* two muscles in relation to each labella, a flexor and an extensor, the flexor being to the inner, the extensor to the other side of the cavities of each lobe, and having origin within the head.

Muscles attached to the base of the labium. One pair of muscles is attached directly to the base of the labium. These are a pair of spindle-shaped muscles, each of which arises from the under surface of the basal chitinous support of the maxilla and is inserted into a ridge of chitin projecting from the groove which separates the labium from the under surface of the head (plate XIX, fig. 1, and XVII, fig. 1, *l.m'*). DIMMOCK describes these muscles in *Culex* as extending along the labium.

The clypeus, or epistom, is the anterior projecting hood-shaped portion of the face from which the proboscis is suspended. It is limited above from the rest of the head by a deep groove; behind and to the right and left of this groove arise the antennae which are to some extent supported by the upper surface, this being slightly hollowed out for the reception of their basal joints; at the sides and posterior are the genae or cheeks, separated from the clypeus by grooves. In transverse section the clypeus appears as a blunt, wedge-shaped piece, the thinner end of which is formed by the upper wall of the pharynx (plate XVI, fig. 2), surrounded below and its sides by a U-shaped area (plate XVII), which for the most part eventually breaks up into the parts forming the proboscis.

From the anterior wall, and from that part of the under surface of the clypeus which forms the roof to the labrum at its origin, project two plates of chitin (endosternites) for some little distance (plate XVIII, fig. 1, *f*): these are approximated below and have an upper and a posterior free edge and two surfaces, inner and outer; the upper posterior angle is lengthened into a blunt process (plate XVI, fig. 2, *f*). These plates are homologous to the fulcrum of other Diptera—for example, *Musca*, *Eristalis*—which have a proboscis capable of extension and retraction. The fulcrum of such Diptera is greatly developed, and moves around an axis at the anterior angle of the head, and encloses the pharyngeal muscles. In the Culicidae the proboscis is fixed in a more or less permanently extended position, and the fulcrum is ill-developed and firmly attached to the anterior wall of the head.

The inner walls of the clypeus afford attachment to three sets of muscles :—

1. Muscles in connection with the labrum.
2. Muscles to the base of the epipharynx.
3. Muscles in connection with the pharynx.

1. Dimmock, *The Anatomy of the Mouth parts, etc., of some Diptera.* Boston, 1881. P. 18.

The muscle attached to the labrum on each side consists of two bundles of fibres lying side by side, having an extensive origin from almost the whole of the upper median surface of the clypeus from before backwards. Their fibres are directed backwards and collect together in a fan-like manner, to be inserted into the projecting chitinous base of the labrum (plate XVIII, fig. 1 and XVII, fig. 1 *lbr.m.*).

The muscles in connection with the base of the epipharynx are two lateral groups arising from the lateral outer wall and free edges of the fulcrum ; a few fibres probably arising from the adjacent inner wall of the clypeus. The fibres project vertically downwards, and are inserted into the horizontal plate of chitin on either side of the epipharynx (plate XVI, fig. 2 *e.m.*)

The third set of muscles arise from the upper inner surface of the clypeus on each side of the labral muscle mass ; the fibres run backwards and downwards to be inserted into the upper chitinous plate of the ascending portion of the pharynx—each muscle being divided into a central and two lateral portions, inserted into the central membranous and anterior and posterior chitinous portions of the wall respectively (plate XVIII, fig. 1, and XVII, fig. 1 *p.m.*). The remainder of the clypens is occupied by tracheae and nerves for supply of the above muscles, and it is lined by loose spongy fatty connective tissue.

The pharynx is that part of the alimentary tract, lined with chitin, which extends from the base of the proboscis to the commencement of the oesophagus at the junction of the head and neck. It consists of two portions, a short anterior ascending and a longer horizontal portion, the latter passing through the ganglionic ring formed by the supra- and infra-oesophageal ganglia and their commissures. Here it forms a large chamber—the pumping organ. DIMMOCK[1] describes this part of the pharynx as the oesophagus. The first part of the pharynx is narrow and is a tubular continuation of the epipharynx above and the hypopharynx below ; it passes upwards and backwards, ending opposite the furrow separating the clypeus from the head. Here the pharynx suddenly turns backwards and is continued on as the second part of the pharynx. The first part of the pharynx consists of two plates of chitin, an upper and a lower ; the former limits the clypeus internally ; it is not completely chitinous, in fact only its anterior and posterior portions are chitinised and thin off towards the centre of the plate which consists of a membrane covered with flattened epithelial cells (plate XVIII, fig. 1, and XVII) ; to this membrane are attached the oblique central fibres of the pharyngeal muscle. On the pharyngeal surface of the anterior chitinous portion of this upper wall of the pharynx are a few low conical papillae (taste papillae) (plate XVIII, fig. 1). The posterior upper edge of this wall is curved slightly outwards upon itself and is attached to the upper wall of the second part of the pharynx by a folded band of chitin.

The ventral wall of this part of the pharynx is a stout plate of chitin, anteriorly continuous with the hypopharynx, posteriorly with the ventral wall of the second

1. Dimmock, *The Anatomy of the Mouth parts, etc.* Boston, 1881. P. 13.

portion. Anteriorly and laterally it is curved upwards, and unites with the sides of the clypeus (plate XVII, fig. 1). From its under surface near its posterior edge it gives off on each side a hook-like ridge of chitin (plate XVIII, fig. 1, *x*) from which the muscles of the salivary receptacle have origin. DIMMOCK describing the pharynx states 'the channel for the passage of food turns upwards and then backwards again, passing in its course a place where its wall approximate dorsally and ventrally; this narrowing of the walls is probably a valve to prevent the return of fluids to the mouth during the pumping process.'

In *Anopheles costalis*, situated in this position and attached to the upper surface of the slightly horizontally bent posterior end of the ventral chitinous plate, is a peculiar ridge of chitinous stout hair-like processes, which curve forwards so that their tips lie in the angle between the upper surface of the first and second parts of the pharynx. The hairs are of two kinds, an anterior large set—probably a single row—and a posterior, small, fine set situated in a clump immediately behind the former. The larger hairs consist of a short stout shaft firmly embedded in the chitinous pharyngeal wall; this shaft supports a cup with a free rim curved outwards; within the cup lies the oval-shaped bulbous extremity of the base of the hair; this bulbous extremity contains a single large cell. The remaining free portion of the hair curves forwards and tapers to a fine point, and appears to have a central shaft enclosed within a chitinous cuticle from which barb-like processes project. The hairs of the posterior set are much finer and shorter, and are more numerous; they appear to be simple in character. In transverse section (plate XVIII, fig. 2) this structure presents to some extent the appearance of 'rods and cones.' The suboesophageal ganglion lies in close proximity to this structure, but no nerve fibres have been traced to communicate with these specialised hairs, although such probably exist. That in the first place these hairs act in conjunction with the general conformity of this part of the pharynx as a valve to prevent the regurgitation of blood back into the mouth during the action of the pumping organ seems to admit of no doubt; on the other hand such specialisation in structure would lead one to suppose that they possess also a sensory function.

The mechanism of the proboscis. The mosquito, when alighting on the surface of the skin for the purpose of sucking blood, immediately raises the palpi almost at right angles to the proboscis. After probing about with the labellae for a suitable spot to pierce the skin, it plants them firmly on the surface, the proboscis being directed a little forwards. A moment later the labium is seen to bend backwards near its junction with the head, the stylets, remaining straight, becoming thus uncovered. The bending of the labium becomes more marked as the stylets sink into the skin, the angle of the bend travelling towards the middle of the length of the proboscis, so that when the stylets have entered the skin to nearly their full extent, the labium is bent double beneath the head of the insect. RÉAUMUR was the first, probably,

to describe and figure the manner in which the labium was disposed of during the puncture of the skin. The stylets probably enter the skin as one piece, being guided by the tip of the labium and supported on each side by the basal portions of the labellae. The piercing of the skin is brought about by muscular force directed from the body of the insect, the muscles attached to the bases of the stylets serving to keep them rigid. The withdrawal of the stylets is accomplished by the powerful retractor muscles attached to the chitinous prolongations of the maxillae, and the muscles described in connection with the bases of the other mouth parts. During the process of extraction, while the stylets are slowly sinking into the groove on the upper surface of the straightening labium, the insect keeps the labellae pressed firmly upon the skin. After they have emerged, the labellae spring together over their tips.

By a careful study of the minute anatomy of the proboscis, as detailed above, it is not difficult to suggest a method by which the mature larvae of *F. nocturna* may escape from the proboscis. As above mentioned the dimensions of this larva are 1·006 mm. long and 0·025 mm. broad. It is therefore evident, taking into consideration the dimensions of the several parts of the proboscis, that the most likely method of gaining access to the proboscis from the head is by entering the body of the labium, the structure and disposition of which would easily admit of this. It has been suggested that the larvae lie among the stylets—in which case it will be seen from the study of the attachments of these appendages that the larva would in its course, necessarily have to pierce a stout layer of chitin, a procedure exceedingly improbable. But the evidence that the larvae do reach the labium is now conclusive. Low[1] in sections of the proboscis found them there ; and although he describes them as 'making an independent passage through the base of the labium and pushing forward along the proboscis between the labium and the hypopharynx amongst the stylets, where they are found stretched along the length of the proboscis head foremost,' the illustrations of his sections of the proboscis shew the worm in the body of the labium, and he cannot have been intimately acquainted with the minute and most delicate anatomy of these parts. These illustrations certainly do not shew the worm 'amongst the stylets,' but in the tissue of the labium.

Grassi and Noe[2] often found *F. immitis* in the labia of mosquitoes (*Anopheles claviger*) which had fed on the blood of an infected dog ; and we ourselves, once in a dead mosquito, and again in a living insect, found the larvae alongside the tracheae of the labium.

The question then arises as to how the larva leave the body of the labium and reach man, since it must be presumed that their presence in such an organ as the proboscis indicates that they subsequently leave that organ during or about the time of puncture. Judging from the condition of the larva at this stage, which

1. Low, *British Medical Journal*, 1900. Vol. II, June 16.
2. Grassi and Noe, *British Medical Journal*, 1900. Vol. II, p. 1306.

shows a complete alimentary canal and reproductive apparatus (although immature) similar in site and arrangement to those of the adult worm as found in man, it seems certain the next stage in the life history is carried out in the definitive host—man. It has been suggested, that as mosquitoes can be sometimes observed feeding on such as bananas, that the filariae are capable of exercising a selective instinct for their escape at the time of puncture: and it has been further suggested that possibly the filariae may escape into banana and other food stuffs, and either undergo a further period of their life history in the external world, or without further change be introduced into the alimentary tract of man. All these suggestions appear to us exceedingly improbable. We have previously shewn,[1] and there is a considerable amount of other evidence to support the facts, that a fertilized female mosquito of the blood-sucking species of West Africa requires blood regularly for the maturation of her ova, and that she will have blood and nothing else: and since those species capable of carrying human filaria frequent the neighbourhood of human habitations, they will for the whole period of their existence feed on blood, and generally on human blood—so that the possibilities of the escape of the filariae into banana and other substances are extremely vague, and further, it becomes quite unnecessary to suppose the possession by the larvae of any selective instinct. The occurrence of the larvae in such a position leads one to presume that they leave it before, during or after the act of suction of the blood; and GRASSI and NOE[2] claim to have infected a dog by the bites of *Anopheles* infected with *F. immitis*, although, since a single broken immature worm only was discovered, *post-mortem*, some sixteen days after the mosquitoes had been allowed to bite them, this experiment urgently requires confirmation. These investigators, however, assert that in specimens of the numbers of mosquitoes which were allowed to bite the dog, before the experiment, larvae were found in their labia, while after the experiment, many labia were dissected and found empty.

GRASSI and NOE in their article go on further and describe how the larvae leave the labium. After drawing attention to the bending of the labium, as the stylets gradually penetrate the skin, so that the angle formed advances from near the base to the middle of the labium until the labium appears almost completely doubled, they 'add the two halves of the olive and the little tongue resting against the skin of the animal, which is punctured, embrace the six pieces penetrating the skin. It is certainly through the bending of the labium, stuffed with filariae, that is brought about the rupture of the integuments of the labium along the dorsal groove, and through the rupture thus produced come out the filariae to penetrate the body of their definitive host. It is difficult, as everyone will understand, to enter into further particulars. In some cases we believe that we positively found the rupture in the middle of the length of the labium in correspondence with the loop. It seems to

1. *Report of Malaria Expedition to Nigeria*, 1901. Part I, chap. iv.
2. Grassi and Noe, *British Medical Journal*, 1900. Vol. ii, p. 1306.

us also that the two halves of the olive and the little tongue being in the above-mentioned position have an importance in directing the movements of the filariae towards the wound made by the stylets. Perhaps the gases emitted in the first moment of the bite help the entry of the filariae into the body of the definitive host.'

One cannot read this paragraph without being struck with the remarkable ingenuity displayed in its account of how the filariae leave the proboscis of the mosquito. But a very careful and exhaustive study of the structure and relations of the parts forming the proboscis has convinced us of the utmost difficulty the most inquiring of observers would experience in deciding the occurrence of any such slit in the upper surface of the labium, as the authors believe they have seen. Furthermore, the upper surface of the labium is composed of chitin almost as thick as that on the outer surface (plate XV, fig. 3). Moreover, from the illustration of the longitudinal section of the proboscis accompanying Low's article, it appears to us that the head of the filaria in the labium is considerably beyond the middle of the labium, in fact appears to reach the distal end of the labium proper—as MANSON[1] says, 'to the tip of the proboscis.' Such a position, if the filariae escape in the manner GRASSI and NOE imply, would necessitate their exit, middle part first, at the bottom of the very acute angle formed by the two almost completely folded parts of the labium. The difficulties involved in such a method of exit appear to us insurmountable.

Referring again to the structure of the extreme tip of the labium (page 80), we have stated that at about 0·16 mm. from the tip of the proboscis the labium proper appears to end bluntly but its upper surface is found to continue on, gradually tapering to a blunt point covered with fine hairs. And again (page 81), above and resting between these areas (lateral areas on the end of the labium proper) is the concave tip of the labium (seen as a concave band of chitin in section) on which the stylets rest ; these three parts (the two areas and the concave chitinous band) enclose a roughly triangular area covered by a delicate membrane thrown into folds ; above it extends along the under surface of the tip of the labium, and on each side is in connection with the bases of the labellae.

When the tip of the proboscis is applied to the surface of the skin, it has been seen that the two labellae swing apart and are rotated so that their inner surfaces are in contact with the skin, and that the piercing stylets are directed in their course by the concave upper surface of the extreme end of the labium. By the swinging of the labellae the delicate folded membrane is somewhat stretched and is close to the surface of the skin. This membrane is exceedingly delicate so that in transverse section even with the high powers of the microscope ($\frac{1}{12}$ O.E.) the sections of its folded edges are represented by thin fine lines. It will thus be seen that this is the most delicate part of the labium ; and as both Low indicates in his illustration and

Periodicity. It was this phenomenon, and this alone, which led MANSON to regard *F. nocturna* and *F. diurna* as distinct species. And certainly, in the limited condition of the knowledge of the subject, it was a very natural conclusion, one large set of cases which had been examined, shewing a characteristic periodicity with a maximum number of embryos present in peripheral blood at midnight, and a smaller set presenting the reverse conditions, a maximum number at midday. The departure from this interesting regularity to be first noted, was recorded by THORPE in the Tonga Islands where a large percentage of the adults shewed symptoms of elephantiasis, and where an examination of a large number of natives proved the presence of embryos in their peripheral blood both during the day and during the night in approximately equal numbers, and moreover shewed that the embryos were present throughout the whole of the day.

We have already given details of several cases illustrative of the same conditions (table VII), and furthermore we have shewn (tables VIII and X) that cases of filarial infection occur in whom the hour at which the maximum number of embryos is present in peripheral blood is not mid-day and midnight, but may be any other hour—3, 6, or 9 a.m. or p.m. And besides we have shewn that 'pure' cases of *F. diurna* and *F. nocturna* are considerably less frequent in West Africa than these irregular cases.

The definitive hosts. THORPE, probably bearing in his mind the classical experiment of MACKENZIE, and the repetition of that experiment in another case by MANSON, by which it was proved that by a change in the habits of a case of *F. nocturna*, the periodicity of the embryos could be completely inverted, becoming thus similar to that of *F. diurna*, explained the peculiar phenomenon of the occurrence of the embryos in the blood of the natives of the Friendly Islands by the habits of the natives, which he thus describes from MARINER's classical account of the Tonga Islands :

'The natives employ themselves in conversation not only at any time during the day but also at night. If one wakens, and is not disposed to sleep again, he wakens his neighbour to have some talk. By and by, perhaps they are all aroused, and join in the conversation. It sometimes happens that the chief has ordered his cooks in the evening to bake a pig or some fish and bring it hot in the middle of the night with some yams. In this case the torches are lighted, and they all get up to eat their share, after which they retire to their mats ; the torches are put out, some go to sleep, and others talk perhaps till daylight.'

Similar habits are in practice among the natives of the whole of West Africa, but to a larger extent and on a larger scale. We were often told by natives from different parts of the Coast that it is common practice in the respective countries to which they belong, to sing and dance the whole night through, especially on moonlight nights. In fact we have ourselves heard the midnight orgies in the native

towns which we visited, and especially of the Kroo boy gangs in the towns of Southern Nigeria. Moreover, we often observed, especially in those towns where civilisation was very backward, the natives asleep during the middle hot part of the day; indeed, the Kroo boy in English Government employ steals a mid-day nap whenever he can. These habits have been practised, no doubt, for generations, and probably were prevalent to a much greater extent for years before the influence of Europeans was felt. Such conditions would, in a great measure, account for the variety in the cases of filarial infection we met with in West Africa, and which THORPE observed in the Friendly Islands, and point strongly to the identity of the two embryos, or rather to the phenomenon of the accommodation of the one or the other or of an original embryo perhaps exhibiting no periodicity whatever, to the varying habits of the natives who formed their habitat.

The intermediary host. *F. nocturna* has been successfully cultivated in several species of mosquitoes of both genera. In West Africa, after several attempts, we were able to cultivate this embryo in *Anopheles costalis;* but all our efforts to cultivate *F. diurna* failed. But this is not remarkable, for, if *F. diurna* had been evolved in consequence of the habits of the natives, it is not unnatural to expect that its intermediary host is an insect, probably a mosquito, not essentially nocturnal in its habits such as *A. costalis*, but one whose habits are diurnal.

Analogy with avian filariasis. In the chapter on Avian filariasis we describe eleven new species of filariae, each having a different embryo; in fact, we were soon able after a little practice to decide the species of the worm even by a study of the stained specimen of the embryo. Each species then possesses distinct adults, which give rise to a characteristic embryo. This would suggest a similar condition among human filariae, and thus that *F. diurna* and *F. nocturna*, being indistinguishable in fresh and stained specimens, have a common adult form.

The adult form. The adult of *F. nocturna* is well known—*F. bancrofti.* The adult of *F. diurna* has not yet been described, unless *F. loa* be that form. Now, the distribution of *F. loa* is, as far as we can ascertain, limited to the West Coast of Africa, and MANSON makes the same statement. It has not been met with in any other part of the world,* and the occurrence of a worm of the length of *F. loa* occurring under the conjunctiva of the eye, cannot possibly have been overlooked anywhere.

F. diurna, as far as we at present know, is also apparently limited to the West Coast of Africa, and has been found in some cases of natives in which *F. loa* has been removed from the eye—although this is not remarkable as anything more than an ordinary coincidence, considering the prevalence of *F. diurna* cases on the Coast. Moreover cases of *F. loa* have occurred in which no embryos could be demonstrated in the blood.

* Stossich states that it occurs in the Antilles and Guiana, but Manson says, in his latest edition of *Tropical Diseases*, 1900, 'it is peculiar to the West Coast of Africa.'

The conditions in the Friendly Islands, previously often referred to, may perhaps be quoted as an exception to the statement above—that *F. diurna* is limited in its distribution to West Africa—since the embryos cannot be regarded as nocturnal. Probably this condition will be found to be much more extensively distributed. On the other hand we have described the embryos of *F. loa* as very similar to those of *F. nocturna* : but on closer study some points of difference may be noted in the disposition and number of the spots. Such a close resemblance indicates either that they are identical with *F. diurna* and that, therefore, *F. loa* is the parent form of *F. diurna*, or that, being very much alike in all other respects except in the matter of the spots as just mentioned, they are intended for a more or less similar life history in their intermediary hosts.

To sum up, although the weight of evidence is on the side of the identity of *F. nocturna* and *F. diurna*, there are many points which remain to be cleared up before the question can be settled. The *F. loa* has introduced a serious difficulty into the subject, and it appears to us that a solution of the mystery can only be obtained when the embryos in a pure case of *F. diurna* have been successfully and completely cultivated in their intermediary host—which is still to be discovered—to the final larval stage, and perhaps it may become necessary to perform experiments of infection of man by the use of infected intermediary hosts before a complete solution is procured.

APPENDIX

NOTES ON A COLLECTION OF MOSQUITOES FROM WEST AFRICA, AND DESCRIPTIONS OF NEW SPECIES

By F. V. THEOBALD, M.A., F.E.S., etc.

The collection of mosquitoes brought back by the members of the expedition from the West Coast of Africa contained twenty-six distinct species. Of these only five had been previously described. Thirteen of the new species are described in my Monograph of the *Culicidae* shortly to be published by the Trustees of the British Museum, and the remaining new ones here.

The collection includes the genera *Anopheles* Meigen (two species), *Mucidus* Theobald (one species), *Eretmapodites* Theobald (one species), *Stegomyia* Theobald (five species), *Culex* Linnaeus (nine species), *Panoplites* Theobald (one species), *Taeniorhynchus* Arribalzaga (modified) (two species), *Aedes* Meigen (one species), *Uranotaenia* Arribalzaga (three species).

The collection contained over two hundred and fifty specimens, including two midges (*Chironomidae*). Some of the types have been given me by the collectors for the British Museum.

Genus *Anopheles*. Meigen (1818)

(*Syst. Beschr. Eur. Zweifl. Ins.* p. 1-13, 1818)

I. *Anopheles costalis*. Loew

(*Berlin Ento. Zeitschr.* p. 55, 1866)

A number of this species taken at Bonny, Duke Town, Bugama, Bakana, Akwete Prison, s.s. Sobo (off Bakana), Lokoja, and at Old Calabar. They show considerable variation both in colour and size, but the costal markings and the spots on the femora remain distinct in all the specimens. Those from Old Calabar are considerably paler and somewhat smaller than those from Bonny. The specimens also show considerable variation in leg banding, it being almost absent in some, very distinct in others.

They were captured during the following months--April, in Duke Town; May and June, at Bonny; August, at Akwete; September, at Lokoja; in June, off Bakana; and June at Opobo.

II. *Anopheles barbirostris*. Van der Wulp var. *Africanus*

(*Leyden Museum Notes*, VI, p. 48)

Three dark ♀ *Anopheles* taken at Old Calabar in April are undoubtedly this species. They resemble in all structural respects the Asiatic form. The only difference to be noticed is that some pale scales are scattered over the wings, and there are no traces of leg banding. There is nothing upon which a new species could be founded, but they are certainly a local variety, and they look longer-legged than the Malay and Indian specimens I have seen.

The examination of the ♂ ungues *might* prove it to be quite distinct. I propose to call it variety *Africanus*; the variety based solely on the mottled wing scales.

APPENDIX

Genus *Mucidus*. Theobald (1901)

(*Mono. Culicidae*, Vol. I)

A single species of this genus occurs in the collection, represented by five specimens.

The characters of the genus *Mucidus* are as follows :—head clothed with narrow curved, forked upright, and *long twisted scales*. Thorax with narrow curved scales and long twisted ones, which are apically expanded. Abdomen densely scaled, the scales giving it a ragged appearance, Legs banded, densely scaled with projecting scales ; fore and mid ungues of the ♂ unequal, the larger with two, the smaller with one tooth ; hind ungues equal, small, toothed ; in the ♀ all the ungues are equal, very thick, uniserrated.

Wings covered with broad pyriform scales, many parti-coloured. Antennae 14-jointed in ♀. Palpi of ♀ half as long as the proboscis ; of the ♂ 6-jointed, a little longer than the proboscis. The venation of the wing is much as in *Culex*, but the posterior cross-vein is nearer the apex of the wing than the mid cross-vein. The insects have a mouldy appearance, due to the long twisted scales. The genus occurs in Australia, East Indies, Malay Peninsular, and the West Coast of Africa. They are often vicious biters.

Mucidus africanus. Theobald

(*Mono. Culicidae*, Vol. I)

Five specimens of this distinct species were taken at Asaba in August, and can at once be recognized from other West African mosquitoes by the densely scaled legs and ragged appearance of the body.

Genus *Eretmapodites*. Theobald (1901)

(*Mono. Culicidae*, Vol. I)

Two species of this genus only occur. The genus *Eretmapodites* is founded on a West African form in which the head is clothed with flat and upright-forked scales, there being no curved scales as seen in *Culex*. The palpi of the ♀ are 4-jointed ; in the ♂ 5-jointed, long and thin, pointed, and with no hair tufts ; the mesothorax clothed with narrow, curved, hair-like scales, and the scutellum with flat scales on the mid lobe. *The last two tarsi* in the ♂ are densely scaled, forming a distinct tuft (Fig. 1, Pl. I) in one species. The fore ungues of the ♂ are unequal, the larger simple, the smaller uniserrated ; the larger one stout, the smaller thin ; mid ungues unequal and simple. Venation much as in *Culex*.

IV. *Eretmapodites quinquevittata*. Theobald

(*Mono. Culicidae*, Vol. I)

A single female of this species from Duke Town, Old Calabar, was taken in May. It is rather damaged and presents no peculiarities. It also occurs at Sierra Leone. The species can easily be told by the ferruginous thorax, with dark longitudinal lines, the abdomen almost black with silvery, oblique, laternal, shining spots and the densely scaled two hind apical tarsi of the ♂ (when fresh). The other species of the genus *E. Austenii mihi* has the tarsal paddle absent.

GENUS *Stegomyia*. THEOBALD (1901)

(*Mono. Culicidae*, Vol. I)

Differs from *Culex*, in that the head and scutellum are both covered entirely with flat scales, that former having a few upright-forked ones as well. Palpi short in the ♀; long in the ♂, apparently five-jointed in the latter, and generally nude. Abdomen banded or plain, but with lateral spots. Fork-cells of the wing rather small. Eggs usually laid singly, not in rafts.

V. *Stegomyia fasciatus*. FABRICIUS (1805)

S. taeniatus. WIEDEMANN (1828), ETC., ETC.

(*Syst. Autl.* 36-13)

This common mosquito, which occurs between latitude 30° N. and 30° S., is evidently abundant in West Africa, specimens in this collection coming from Old Calabar and Bonny. They were captured chiefly in April, May, and July. The majority are rather small specimens, and some of them show the abdominal banding involving both sides of the segments. This species occurs right into Central Africa, and is, perhaps, the commonest tropical and sub-tropical mosquito, biting during the day as well as at night.

It can easily be told by the thoracic ornamentation; the insect is very dark-brown to black, the bases of the abdominal segments with creamy-white bands and white lateral spots, the legs basally white banded, and the thorax with tawny to brown tomentum (scales), with a silver curved line on each side, two narrow parallel ochraceous or yellow lines in the middle and some silvery-white scales on the scutellum, forming a line of three spots. The majority of the specimens in this collection show a pure white line of scales on each side of the space in front of the scutellum, which I have not noticed so plainly before.

VI. *Stegomyia africanus*. THEOBALD

(*Mono. Culicidae*, Vol. I)

Two ♀'s; one from Duke Town, one from Bonny; taken in April and May.

It is very like *S. fasciatus* Fab., but has two lateral oblique silvery side bars to the meso-thorax, no central ornamentation, except a silvery spot in front, and the second tarsal joint of the hind legs is nearly all white. Abdomen generally quite devoid of banding, but one specimen shows faint traces of basal fascia. Giles' *S. gubernatoris*, from India, is very similar but quite distinct.

This mosquito occurs in Central Africa as well as on the West Coast.

VII. *Stegomyia irritans*. Nov. sp.

(Fig. 2, Pl. I)

Head black and grey, the black forming a triangular patch on each side. Thorax chest-nut-brown, with deep-brown, and bright scanty golden scales. Abdomen dark-brown, with narrow, basal, white bands. Legs dark-brown, unbanded.

♀. Head covered with flat, creamy, grey and black scales, the black ones forming a more or less triangular patch on each side and a small area in the middle, a few scattered, black, upright-fork scales over the occiput, around the eyes a narrow line of curved, golden scales; clypeus

black, apparently nude ; palpi testaceous, with dark scales ; antennae dark-brown, with narrow, pale bands, basal joint half testaceous, the inner half darker, base of the second joint testaceous, basal joint with a few small scales on the inner side, and minute curved hairs ; proboscis deep brown ; eyes black and golden.

Thorax deep chestnut-brown, with narrow, curved, deep-brown scales and ornamentation of similar bright golden ones, the latter most prevalent over and in front of the roots of the wings. Scutellum brownish, with flat, black scales on the middle lobe ; narrower, rather curved, creamy ones on the lateral lobes, and with deep-brown border-bristles ; metanotum brown ; pleurae brown, with large patches of creamy scales.

Abdomen deep blackish-brown with narrow, white, basal bands, first abdominal segment rather ochraceous, covered with dusky-black scales and pale-brown hairs ; posterior border-bristles chestnut brown, alternately long and short ; venter mostly creamy white with narrow dark apical bands to the segments ; the dorsal white bands form more or less white lateral spots.

Legs dark brown, pale at the base, femora grey ventrally ; femora, tibiae, and metatarsi spiny ; fore and mid ungues equal uniserrated, hind equal and simple.

Wings with the fork-cells rather short ; scales brown ; first submarginal cell very little longer and slightly narrower than the second posterior cell, their bases about level, stem of the former equal to about half the length of the cell, of the latter nearly two-thirds of its length ; posterior cross-vein a little more than its own length distant from the mid cross-vein.

Halteres ochraceous, with pale scales over the knob, and dark ones on one side.

Length.—3 mm.

♂. Antennae black, with dense black plumes ; palpi pale ochraceous, densely covered with black scales, the antepenultimate joint with two narrow pale rings ; apical joint small, a little more than half the length of the penultimate joint, acuminate, penultimate joint wider than the apical, the antepenultimate expanding at the tip, the last two with long, brown hair tufts on one side, especially the penultimate, a few long hairs on the apex of the antepenultimate, and a few long black bristles on the apex of the last two joints ; proboscis deep brown, almost black. Fore and mid ungues unequal, the larger uniserrated ; hind ungues equal, small and simple. Fork-cells of wings small ; the first submarginal cell shorter and considerably narrower than the second posterior, its stem nearly equal to the length of the cell ; stem of the second posterior cell equal to the length of the cell.

Length.—4 mm.

Habitat.—Bonny.

Time of Capture.—May.

Observations.—Described from a series of ♀'s and a single ♂ in the collection of the Expedition. It is a clearly defined species, with banded abdomen and unbanded legs. The deep chestnut-brown thorax and grey and black head and unbanded legs separate it at a glance from all other African *Stegomyias* I have seen, except *S. nigeria*, from which it differs in thoracic ornamentation, the two parallel pale lines on the mesothorax of *S. nigeria* being absent.

VIII. *Stegomyia nigricephala*. Nov. sp.

(Fig. 3, Pl. I)

Head entirely black. Thorax dark-brown, with bronzy-brown scales. Abdomen black, with small, white, basal, lateral spots. Wings with dark-brown scales, and slightly tinged with brown. Legs dark-brown, unbanded.

♀. Head black (Fig. 3*b*, Pl. I), entirely covered with flat, black scales; clypeus, proboscis, and palpi black; antennae dark-brown; basal joint testaceous on one side, dark on the other; eyes golden.

Thorax black, with rather long, bronzy-brown curved scales, forming a dense matting over the black surface; over the roots of the wings numerous jet-black bristles; scutellum testaceous in the middle at the base, black at the apex, lateral lobes greyish-brown, mid lobe with flat black and grey scales and six (?) black border-bristles; metanotum blackish; pleurae very dark, with three large patches of white scales.

Abdomen (*c*) testaceous at the base, steely-black apically, covered with black scales, each segment with a small, basal, white, lateral spot; venter black, with basal white bands.

Legs dark blackish-brown, coxae and trochanters pale-brown; fore and mid (*d*) ungues equal, uniserrated, hind equal and simple.

Wings slightly tinged with brown; veins clothed with dark-brown scales; fork-cells small, the first sub-marginal cell a little longer but no narrower than the second posterior cell, its stem equal to about two-thirds of the length of the cell; stem of the second posterior as long as the cell; posterior cross-vein nearly twice its own length distant from the mid cross-vein.

Halteres with deep ochraceous stem and fuscous knob.

Length.—4·8 mm.

Habitat.—Bonny.

Time of Capture.—May.

Observations.—Described from a single ♀. The specimen was taken from a native hut. It can at once be told by the entire covering of black scales on the head and the rather long, curved, bronzy scales on the thorax and the unbanded abdomen.

Genus *Culex* L. (1735)

(*Syst. Nat.* 1735)

Palpi short in the ♀, long in the ♂, apical joint of latter usually acuminate, but sometimes clavate. Head clothed with narrow curved, upright-forked and broad flat lateral scales; scutellum covered with narrow curved scales; those on the thorax in three forms, narrow curved, narrow hair-like curved, and flat spindle shaped. Wings having the lateral vein scales linear, as a rule, and the first submarginal cell generally longer and narrower than the second posterior cell.

Eggs laid in rafts.

I have still retained several species in this genus which will have to be removed later.

IX. *Culex duttoni*. Nov. sp.

(Fig. 4, Pl. I)

Thorax dark-brown with golden-brown to golden narrow curved scales, with pale scaled areas in front, over the wings, two pale spots and pale scales in the middle of the back of the mesonotum, continuous with those over the wings. Abdomen with basal creamy-white bands. Legs with banding involving both sides of the joints.

♀. Head dark-brown with narrow creamy curved scales around the eyes, on the back of the occiput and in the middle, those between of a more golden-brown hue; the upright fork scales in front (forming a band around the head) bright brown, those behind creamy, at the sides of the head are a few small white flat scales; the fork scales are very numerous, there is also a row of bright-brown bristles projecting forwards over the eyes; clypeus black; palpi black scaled with a few

pure white ones up one side ; proboscis deep blackish-brown, apex testaceous and with a dull testaceous band on the apical half ; antennae deep-brown. Thorax black, covered rather densely with narrow golden-brown curved scales, and pale rather broader creamy ones arranged as follows :—around the front of the mesothorax, forming a narrow line, a more or less distinct spot on each side about the middle of the mesonotum, a long patch just over the roots of the wings, which bend round and pass up again on to the mesonotum, these latter are almost white ; scutellum brown with narrow curved pale-golden scales, eight median golden-brown border-bristles, with some smaller fine pale golden ones over them ; metanotum deep-brown ; pleurae dark-brown with a few small patches of white scales.

Abdomen (*d*) deep-brown with basal dull creamy-white curved bands, and with more or less evident small lateral and basal pure white spots; border-bristles rather long, lateral ones also long.

Legs with the coxae and trochanters ochraceous ; femora deep-brown, pale, almost white beneath, apex white ; tibiae brown, with slightly paler base and apex, and with pale hairs ; metatarsi with the apex pale banded, fore tarsi with the first and second joints apically and basally pale banded, the third basally banded, the fourth only showing a trace of basal banding. Mid tarsi the same as the fore ; hind tarsi also very similar ; ungues small, equal, and simple ; hind metatarsi longer than the hind tibiae.

Wing with typical brown *Culex* scales ; fork-cells rather long ; first submarginal cell longer and narrower than the second posterior cell, its base nearer the base of the wing, its stem rather less than one-third the length of the cell ; second posterior cell with its branches slightly contracted where they join the wing, its stem rather less than one-half the length of the cell ; posterior cross-vein nearly twice its own length distant from the mid cross-vein. Halteres pale ochraceous.

Length.—4·8 to 5 mm.

♂. Palpi (*c*) dark-brown, with five white broken bands, last two joints with black hairs ; apex of the antepenultimate also slightly hairy, apical joint acuminate ; proboscis deep-brown, with an indistinct pale band ; antennae dark-brown, with deep-brown plumes, faintly banded paler brown ; basal joint deep ferruginous.

Abdomen narrow, the basal creamy-yellow bands prominent. The last segment with creamy-white scales in the middle ; abdomen hairy. Legs banded much as in the ♀, but the last two tarsi seem to be unbanded ; fore ungues unequal and uniserrated ; hind equal, simple and small ; wings with the fork-cells very small, first sub-marginal very little longer, not much narrower than the second posterior, its base nearer the apex of the wing than that of the second posterior cell, its stem slightly longer than the cell, posterior cross-vein about its own length distant from the mid cross-vein.

Length.—5 mm.

Habitat.—Duke Town.

Time of Capture.—April.

Observations.—Described from a series bred from larvae obtained at Canoes Creek, Duke Town. The thoracic ornamentation soon loses its characteristic appearance by denudation, the golden scales only remaining ; the tarsal banding involving both sides of some of the joints and the faintly-banded proboscis should readily separate it from other African species. The banding on the abdomen in the male spreads out laterally in the sixth and seventh segments. The two, sometimes three, white bands on the antepenultimate joint of the male palpus are very characteristic, the most apical band being very wide.

X. *Culex decens.* Nov. sp.

(Fig. 5, Pl. I)

Thorax deep-brown to black with chestnut-brown scales; abdomen almost black with basal uniform white bands on the third to fifth segments, which widen out prominently on the sixth and seventh to form clear lateral spots. Legs dark-brown unbanded.

♀. Head almost black with small narrow curved creamy scales, and numerous dark upright-forked scales, quite black in some lights, the pale scales form a distinct line round the eyes; clypeus dark-brown; palpi deep-black; antennae dark-brown with black verticillate hairs and pale pubescence; proboscis deep bronzy-brown.

Thorax black, deep-brown in some lights, with very narrow curved bright chestnut-brown scales, rather paler in front, two dark median parallel lines show on the denuded surface; bristles deep-brown, especially long and thick over the roots of the wings; scutellum brown with very small narrow curved pale scales, seven bright-brown chaetae to the mid lobe; metanotum brown; pleurae ochraceous and slatey grey, with two patches of white scales, and an elongated patch just over the first two pair of legs.

Abdomen covered with deep blackish-brown scales, the first segment dull ochraceous with two median patches of dull-black scales and long pale hairs, the second to fifth segments with basal white bands, in the fifth the band spreads out a little laterally, on the sixth and seventh the band is rather broken in the middle but much expanded laterally, the eighth segment mainly white; border-bristles longest at the sides.

Legs brown, unbanded, coxae to base of femora pale, venter of femora grey, remainder deep-brown, femora, tibiae and metatarsi, especially of hind legs spiny; ungues small, equal, curved, simple.

Wings with the veins with typical brown *culex* scales; first long vein rather bent about half way along the wing; first submarginal cell longer and just slightly narrower than the second posterior cell, its base nearer the base of the wing, its stem equal to about one-third of its length; stem of the second posterior cell equal to about half the length of the cell; posterior cross-vein nearly twice its own length distant from the mid cross-vein; halteres with ochraceous stem and fuscous knob.

Length 5mm.

♂. Palpi all deep-brown to dull-black, just a trace of a narrow pale band near the base, the apical joint a little longer than the penultimate joint, acuminate, the two last joints with numerous blackish hairs, short and dense on the under surface only, a few also at the apex of the antepenultimate joint, the remainder with short, pale hairs all on the ventral surface, densely scaled below; the palpi are longer than the proboscis by the last joint and the apical third of the penultimate joint; proboscis dark-brown, apex testaceous; antennae grey, with deep-brown bands and brown plume-hairs.

Thorax as in the ♀; abdomen narrow, ornamented as in the ♀. Legs unbanded, traces of a pale knee spot; fore and mid ungues unequal, uniserrated; hind ungues small, equal.

Length.—4·5 mm.

Habitat.—Bonny.

Time of capture.—May.

Observations.—Described from a single ♂ and ♀ in the collection. The abdominal banding of the seventh and eighth segments expanding laterally, serves as a good means of identifying it at a glance.

XI. *Culex maculicrures.* (THEOBALD)
(*Mono. Culicidae*, Vol. I)

Four specimens (two ♂'s and two ♀'s) of this large brown species, bred from larvae taken at Bonny, and hatched during June. The ♀ measures between six and seven mm.; the thorax is dark-brown, with reddish-brown scales, and shows two prominent pale spots, with a pale line running from each backwards, and sometimes one or two pale and indistinct spots in front. The abdominal segments have narrow, apical, dull-yellow borders. The legs are brown and unbanded, but the femora and tibiae have a row of small yellow spots on one side.

This mosquito has a wide distribution in Africa, and Dr. BANCROFT has recently sent it from Australia (Queensland).

XII. *Culex metallicus.* THEOBALD
(*Mono. culicidae.* Vol. I)
(Fig. 14, Pl. III)

A number of this very distinct and pretty species, both ♂'s and ♀'s, taken during July, in the Bush opposite St. Stephen's Cathedral, Bonny.

It can at once be told by the thorax being silvery on the front half, brown on the posterior half, and by the more or less brilliant metallic violet abdomen, which is unbanded, as also are the legs, the femora being silvery at the base.

I have not seen this species from any other district in Africa, but I have the remains of a species very similar to it from Siam. It is only provisionally placed in *Culex*.

XIII. *Culex pruina.* Nov sp.
(Fig. 6, Pl. I, and Fig. 7, Pl. II)

Thorax covered with frosty-grey scales, with traces of two parallel darker lines; abdomen with the fifth to eighth segments with basal lateral white spots, almost forming bands, bases of the other segments slightly paler, in the ♂ with more or less distinct banding. Legs brown, unbanded.

♀. Head brown, clothed with hoary, narrow curved scales, and numerous ochraceous upright-forked ones; eyes black; clypeus, palpi, and proboscis deep-brown; antennae brown, basal joint paler.

Thorax shiny black, covered with thin, hair-like, curved hoary scales, and showing traces of two dark parallel bands on the denuded surface; scutellum with narrow curved hoary scales; metanotum testaceous and ochraceous; pleurae dark-brown above, ochraceous below. Abdomen (Fig. 6, Pl. I) dark-brown, almost black; the fifth to eighth segments with basal white lateral patches, which are most pronounced on the sixth, seventh, and eighth segments; the abdomen shows violet reflections; border-bristles pale. Legs brown, unbanded, ventral surface of the femora nearly white; ungues equal and simple.

Wings (Fig. 7*a*, Pl. II) with pale-brown, typical *Culex* scales; fork-cells rather long and narrow, the first submarginal longer, but no narrower than the second posterior cell, its base nearer the base of the wing than that of the latter; its stem about one-fourth the length of the cell. Stem of the second posterior cell about one-half the length of the cell; supernumerary cross-vein long and sloping, forming a very acute angle with the mid cross-vein; posterior cross-vein longer than the mid, and about one-and-a-half times its own length distant from it. Halteres ochraceous.

Length.—5 to 5·2 mm.

♂. Palpi ochraceous, covered with dark-brown scales, a small pale band near the base, the last two joints with dense black hairs, and also on one side of the apex of the antepenultimate joint; antennae banded, brown and grey, with deep flaxen-brown plumes; proboscis deep brown, apex testaceous. Abdomen narrow, expanding apically, the fourth and fifth segments with basal white bands, the sixth, seventh and eighth with pale bands expanded laterally, the ninth mostly white, moderately hairy. Fore and mid ungues unequal (Fig 7*b*, Pl. II), the larger one uniserrated, the smaller with a tooth near the base, hind equal and simple.

Length.—5 to 5·3 mm.

Time of capture.—August.

Habitat.—West Africa.

Observations.—Described from five specimens in this collection. A very distinct species with hoary scaled thorax, which has a dull golden tinge however in some lights, the banding of the abdomen and the form of the cross-veins are also characteristic.

XIV. *Culex invenustus.* Nov. sp.

(Fig. 8 and 9, Pl. II.)

Thorax dark-brown; abdomen black, unbanded and unspotted. Legs dark-brown, with pale-grey bases, fore and mid femora thick.

♀. Head (Fig. 8*b*, Pl. II) almost black, with narrow ochraceous-grey curved scales, blackish and brown, thin, upright-forked ones, flat white scales at the side, and a narrow white border round the eyes; eyes black; palpi short, dark-brown; proboscis rather short, dark-brown testaceous at the tip; antennae dark-brown, basal joint black, last two joints very hairy; clypeus black; thorax dark steely-black, covered with small, dull bronzy-brown, flat scales, forming a complete layer; when denuded the thorax shows three narrow parallel black lines; scutellum greyish-brown, with narrow curved pale scales and black border-bristles; metanotum dark-brown; pleurae ochraceous brown, slightly darker in front.

Abdomen deep blackish-brown, narrow, unbanded and unspotted; posterior border-bristles dull-brown; venter rather pale.

Legs unbanded, deep-brown, coxae pale, fore and mid femora (Fig 9, Pl. II) swollen, hind femora narrower, pale beneath, tibiae and metatarsi rather bristly; ungues small, much curved, equal and simple. Wings with brown scales of typical *Culex* form; fork-cells moderately long, the first sub-marginal considerably longer, but no narrower than the second posterior cell, its stem about one-fourth the length of the cell, its base nearer the base of the wing than that of the second posterior cell, stem of the latter, half the length of the cell; posterior cross-vein nearly twice its own length distant from the mid cross-vein.

Length.—3·5 mm.

Time of capture.—June.

Habitat.—Degama, West Africa.

Observations.—Described from a single perfect ♀. It can at once be distinguished by the general brown colour, unbanded and unspotted abdomen, and by the swollen fore and mid femora. It comes very near my *Culex longipes* in appearance.

The much swollen femora are probably of generic value, but I have only seen two specimens, both ♀'s, showing this character, and hence place them provisionally in *Culex*. *C. longipes mihi* comes from the Malay Peninsular.

XV. *Culex nebulosus.* Nov. sp.

(Fig. 10, Pl. II)

Head dark-brown with a pale border round the eyes. Thorax brown with tawny-brown scales. Abdomen dark-brown with traces of dull, grey apical lateral spots. Legs unbanded.

♂. Head dark-brown with narrow, curved, dull golden-brown scales, numerous brown, upright-forked ones, and a distinct white border round the eyes, and white scales at the sides; clypeus, proboscis, palpi, antennae brown, basal joint of the latter testaceous at the base; eyes black and golden.

Thorax shiny-black, covered densely with very narrow, curved, tawny-brown scales, and showing two darker parallel lines on the denuded surface, numerous golden-brown and dark-brown bristles over the roots of the wings; scutellum brown with very narrow, almost hair-like, pale scales, seven bristles to the mid lobe; metanotum dark chestnut-brown; pleurae brown and ochraceous with scanty flat white scales.

Abdomen deep-brown, unbanded, with dull violet reflections, indistinct apical, creamy-white lateral spots (Fig. 10*c*, Pl. II); venter grey and brown.

Legs brown, unbanded; coxae and trochanters ochraceous, the former with dull white scales; femora dull, pale ochraceous beneath.

Wings (Fig. 10*a*, Pl. II), with brown scales of typical *Culex* form; first submarginal cell considerably longer and a little narrower than the second posterior cell, its stem less than one-third the length of the cell; stem of the second posterior equal to about half the length of the cell; posterior cross-vein considerably longer than the mid cross-vein, about its own length distant from it.

Halteres with slightly fuscous knob and ochraceous stem.

Length.—3 to 3·5 mm.

Time of capture.—April, August, September.

Habitat.—Old Calabar.

Observations.—Described from six specimens. A rather obscure species, with traces more or less distinct of pale, apical, lateral, abdominal spots, and rather marked cephalic ornamentation.

XVI. *Culex fatigans* Wied (1828)

(*Aussereurop. Zweiflug Ins.* p. 10)

This common mosquito also occurs in West Africa, but is only represented in the collection by a single ♀. It does not seem common, however, in this part of Africa judging from the collections I have received from Bonny and the neighbourhood, but, perhaps, owing to its commonness, it has not been collected. Like *S. fasciatus* Fab. its distribution is very wide, and it is one of the most troublesome species, biting chiefly at night and acting as one of the *Filaria* carrying hosts.

It closely resembles *Culex pipiens* L. of Europe and North America, but it can always be told by the stem of the first submarginal cell being relatively much longer than in *C. pipiens*. The stem in *C. pipiens* is never less than one-fifth the length of the cell, in *C. fatigans*, it is always more, often only one-third the length.

XVII. *Culex rima*. Nov. sp.

(Fig. 11, Pl. II)

Thorax deep-brown. Abdomen deep-brown, with metallic-bronze and violet reflections, white, apical, lateral spots and grey venter. Legs deep-brown, unbanded. Wings with rather broad scales like *C. atratus*, THEO. Ungues small, curved, equal, and simple.

♀. Head dark-brown, with narrow, curved, dull-grey scales and numerous short, upright, black ones; clypeus (*b*) black, *with a transverse sulcus*; antennae brown, with reddish-brown basal joint; proboscis black, testaceous at the apex; palpi rather thick, black.

Thorax deep-brown, with very minute, narrow curved, dull-brown scales and long black, backwardly-projecting bristles; scutellum deep chestnut-brown in the middle, greyish apically, with narrow dull-brown curved scales and black border-bristles; metanotum deep-brown; pleurae greyish or greyish-brown.

Abdomen bronzy-black, with deep bronzy-green and deep-violet reflections when held in different lights, the four posterior segments with *four distinct, white, apical spots*; posterior border-bristles dull-brown, short; apex pubescent. Legs deep-brown; the coxae very pallid, and also the venter of the femora; the metatarsi and tarsi with somewhat dull, ochraceous reflections ventrally. Ungues small, equal, and simple.

Wings (Fig. 11*a*, Pl. II) densely scaled towards their apices with rather short, thick, brown scales (a^1) (as in *C. atratus* THEO.); fork-cells rather short, first submarginal cell longer and narrower than the second posterior cell, their bases not nearly level, that of the former, nearer the base of the wing; stem of the first submarginal equal to about half the length of the cell; stem of the second posterior as long as the cell; posterior cross-vein slightly curved in the middle, nearly three times its own length distant from the mid cross-vein; fringe brown, very dark at the apex of the wing.

Halteres with ochraceous stem and fuscous knob.

Length.—2·8 mm.

Habitat.—Old Calabar.

Time of capture.—April.

Observations.—Described from three ♀'s. A small species with very distinct abdominal ornamentation. In two specimens the thorax is paler brown. It is closely related to the little black *Culex* I call *Culex atratus*, common in Jamaica. The peculiar wing scales and general facies of these two species will necessitate their removal from *Culex*, but I am waiting for more material as I have only received one damaged ♂ (*C. atratus*) of this group.

XVIII. *Culex invidiosus*. Nov. sp.

(Fig. 12, Pl. II)

Head deep-brown with greyish sheen, seen in some lights; thorax deep chestnut-brown; abdomen blackish-brown, unbanded and unspotted; pleurae paler brown; legs deep-brown, coxae and bases of femora pale.

♀. Head deep-brown, almost black, covered with dull ochraceous grey narrow curved scales over the occiput, black upright-forked ones, and small flat dull white lateral ones, a narrow, rather indistinct grey border round the eyes; clypeus deep chestnut-brown; proboscis deep blackish-brown; palpi short, densely black scaled; antennae brown, basal joint testaceous in the centre.

Thorax brown, with narrow curved dull golden-brown scales, and black bristles; scutellum rather shiny, rich brown, with narrow curved dull-grey and brown scales, six or seven bristles to the mid lobe, and four each to the lateral lobes; metanotum deep-brown; pleurae pale ochraceous brown.

Abdomen deep-brown, with slight deep-violet reflections; narrow; border-bristles short and pale, apex testaceous, rather hairy; venter brown, hairy, testaceous at the base; the scales at the sides, in some lights under the microscope, have a dull violet-grey hue.

Legs deep-brown, with violet reflections, coxae pale ochraceous, with a number of pale hairs; venter of femora pale ochraceous, tibiae and bases of the metatarsi with a few bristles; ungues small, equal, and simple.

Wings with typical brown *Culex* scales, first submarginal cell longer and a little narrower than the second posterior cell, its stem is about one-third the length of the cell, its base nearer the base of the wing than that of the second posterior, stem of the latter about two-thirds the length of the cell; mid cross-vein long; posterior cross-vein not quite twice its own length distant from the mid.

Halteres with ochraceous stem and fuscous knob.

Length.—3·2 mm.

Habitat.—Bonny.

Time of capture.—May.

Observations.—Described from a single ♀. I do not know any species at all resembling it, yet there are no very distinctive characters. The unbanded legs and abdomen, and its general brown color, when roughly examined, make it resemble *Aedes nigra*, but it can at once be told from it by the head and wing scales, which are of typical *Culex* form.

Another ♀ differs considerably in colour, but I can detect no structural difference. It is much paler, of a general ochraceous tint, due to denudation of the scales. The thorax is paler brown with two pale median parallel stripes in front, separated by a darker line, and the scutellum has seven mid bristles, and the venter of the abdomen is paler and grey scaled. Venation, scales, ungues, etc., are similar, and it was taken in the same place and date as the type. I fancy one is full of ova, the other dark with blood.

Genus *Panoplites*. Theobald (1901)

(*Mono. Culicidae*, Vol. II)

This genus differs from *Culex* chiefly in the peculiar formation of the wing scales, which are broad and asymmetrical squamae, concave at their free extremity (Fig. 13, Pl. II). This character will suffice to identify the genus. The eggs are laid singly, and taper to a point at one end. Many of the species are vicious biters, and chiefly occur along river banks. The African species here mentioned acts as the *Filaria* host.

XIX. *Panoplites africanus*. Theobald

(*Mono. Culicidae*, Vol. II)

Quite a number of this species occur in the collection from Asaba taken in June, July, and August. The thickly scaled wings will at once separate it from other *Culices* occurring in

the neighbourhood. The legs are broadly basally banded white, and the femora and tibiae more or less mottled ; the general colour is rich brown, the abdomen being deeper brown, with apical white patches of lateral scales, and similar ochraceous basal ones. Some specimens show apical ochraceous bands ; the scales are not evenly disposed and give the abdomen a slight ragged appearance. The thorax shows characteristic ornamentation under the microscope, the greater surface being covered with golden-brown scales, with lines and patches of silvery-grey scales. The specimens collected at Asaba differ in no respects from those in the other parts of West and Central Africa.

Genus *Taeniorhynchus* Arribalzaga (1891) (Modified F.V.T.)

(*Dipt. Argentina*, p. 47, and *Mono. Culicidae*, Vol. II)

Separated from *Culex* by Arribalzaga chiefly on account of the palpal structure and ungues and banded rostrum. His genus, however, contains three totally diverse species. I have, therefore, remodelled it upon his *T. fasciolatus* (Vide *Mono. Culicidae*).

The only feature I need point out here is that the wings are always covered along the veins with thick elongated scales, giving the wings a densely scaled appearance, but quite different to *Panoplites* in form. I know nothing of the life-history of any of the species in this genus.

XX. *Taeniorhynchus aurites.* Theobald

(*Mono. Culicidae*, Vol. II)

Eight or nine ♀'s of this pretty golden-yellow gnat were taken at Bonny and Ogugumanga. One bears on the label 'Taken in the bush opposite St. Stephen's Cathedral.' They were captured in May, June, and July. It can be told from the other yellow African mosquito by the thorax being honey-yellow and unadorned ; the hind legs have apical dark bands to the metatarsi and tarsi, and the wings brilliant orange-yellow.

XXI. *Taeniorhynchus annettii.* Theobald

(*Mono. Culicidae*, Vol. II)

A ♂ and eight ♀'s taken at Old Calabar at the Vice-Consulate in April, and at Bonny.

It resembles *T. aurites* but the sixth vein is dark scaled ; there is darker thoracic ornamentation and apical dark banding to the fore and mid legs, more or less distinct ; the abdomen has apical deep-violet bands.

Genus *Aedes.* Meigen (1818)

(*Syst. Beschr.* Vol. I, p. 13, 1818)

Palpi short in both ♂ and ♀. Head clothed with both flat and narrow-curved scales, the flat scales predominating ; scutellum with narrow-curved scales only. Fork-cells of the wings moderately long ; scales on the wings very similar to *Culex*, there being always long, thin, lateral scales to the veins, which are not seen in other genera of the *Aedeomyina*.

Two species occur in the genus in Africa.

XXII. *Aedes nigra*. THEOBALD

(*Mono. Culicidae*, Vol. II)

Five ♀'s and one ♂ of this small dark *Aedes* only about 2mm. long. Taken at Old Calabar in April. It can readily be told by its black appearance, unbanded legs, abdomen, and absence of thoracic ornamentation. From the *Uranotaenia* it can at once be distinguished by the relative greater length of the fork-cells.

GENUS *Uranotaenia*. ARRIBALZAGA (1891)

(*Dipt. Argentina*, p. 63, 1891)

Palpi short in the ♂ and ♀ as in *Aedes*, but the fork-cells are very small, especially the first submarginal fork-cell. There are always flat scales, usually brilliant in places on the mesonotum and on the scutellum, and the head is entirely covered with flat scales. Many of the species bite severely. The larvae are often brilliantly coloured with red, blue, and green, and seem to be intermediate between *Anopheles* and *Culex* in structure.

XXIII. *Uranotaenia domestica*. THEOBALD

(*Mono. Culicidae*, Vol. II)

Two specimens of this beautiful *Uranotaenia* taken at Old Calabar at the Vice-Consulate, in April. One badly damaged.

It can easily be identified by the bright, chestnut-brown thorax, with a small, silvery spot on each side in front, another on the roots of the wings, a bright, silver-scaled scutellum; the abdomen is almost black, with white lateral spots, and the legs are black with a white spot at the apex of the tibiae and femora, and a silvery band near the apex of the hind femora.

Length.—4 mm.

XXIV. *Uranotaenia annulata*. THEOBALD

(*Mono. Culicidae* Vol. II)

Three ♀'s and three ♂'s taken at Bonny in May. A very marked little *Uranotaenia*, with chestnut-brown mesothorax and sharply contrasted pale creamy pleurae and head, the latter having a dark median line. The abdomen is brown, and has apical grey or white bands. Legs brown; the hind ones with the metatarsi and first two tarsi with apical white bands, and the last two joints pure white.

XXV. *Uranotaenia caeruleocephala*. THEOBALD

(*Mono. Culicidae*, Vol. II)

Eight ♀'s taken in April at Old Calabar. It is a beautiful little deep-brown species, easily identified by its sky-blue head. The legs and abdomen are unbanded. On the thorax may be seen a line of white scales at the sides, just in front of the wings.

Length.—2·5 mm.

PLATES TO APPENDIX

PLATE I

FIG. 1 *Eretmapodites quinquevittata.*—Fore and mid ungues of ♂, and fore ungues of ♀ : ♂ palpus and apex of ♂ hind legs.

FIG. 2. *Stegomyia irritans.* Nov. Sp. —♂ palpus and cephalic ornamentation.

FIG. 3. *Stegomyia nigricephala.* Nov. sp. *a*, wing of ♀ ; *b*, head ; *c*, abdominal ornamentation ; *d*, fore ungues of ♀.

FIG. 4. *Culex duttoni.* Nov. Sp. —*a*, thorax of ♀ ; *b*, markings on denuded thorax ; *c*, ♂ palpus ; *d*, abdominal ornamentation.

FIG. 5. *Culex decens.* Nov. sp. —♂ palpus.

FIG. 6. *Culex pruina.* Nov. sp.—♂ and ♀ abdominal ornamentation.

PLATE II

FIG. 7. *Culex pruina.* Nov. sp.—*a*, wing of ♀ ; *b*, fore ungues of ♂

FIG. 8. *Culex invenustus.* Nov. sp.—*a*, wing of ♀ ; *b*, head ornamentation.

FIG. 9. *Culex invenustus.* Nov. sp. —Fore leg to first tarsal joint.

FIG. 10. *Culex nebulosus.* Nov. sp.—*a*, wing of ♂ ; *b*, cephalic ornamentation ; *c*, abdominal ornamentation.

FIG. 11. *Culex rima.* Nov. sp. —*a*, wing of ♀ ; a^1, apical wing scales ; a^2, basal scales ; *b*, clypeus.

FIG. 12. *Culex invidiosus.* Nov. sp.—*a*, scutellar bristles ; *b*, wing of ♀

FIG. 13. Wing scales of *Panoplites.*

PLATE III

FIG. 14. *Culex metallicus.* THEOBALD.—*a*, thoracic ornamentation ; a^1 and a^2 enlarged scales ; *b*, ♂ palpus ; *c*, fore and hind ♀ ungues ; *d*, apex of antenna ; *e*, wing fringe ; *f*, ♂ genitalia ; *g*, wing scales ; *i*, another form of wing scales ; *h*, fore and hind ♂ ungues.

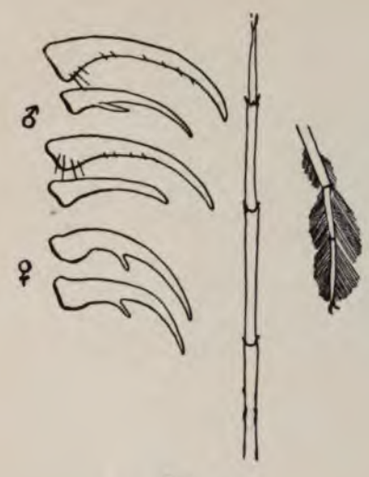


FIG. 1

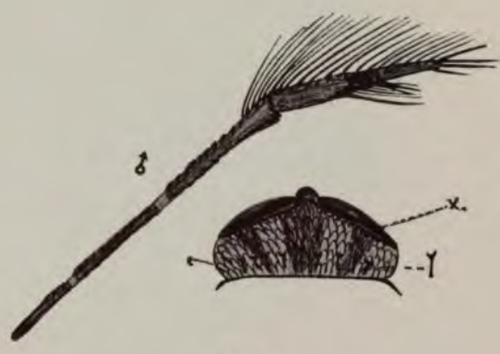


FIG. 2

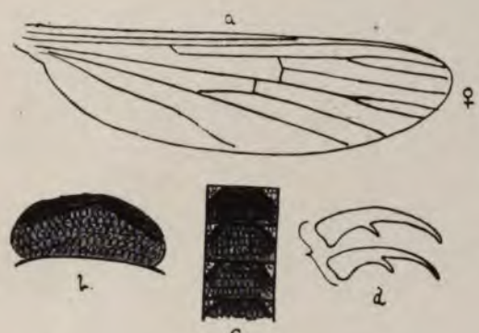


FIG. 3

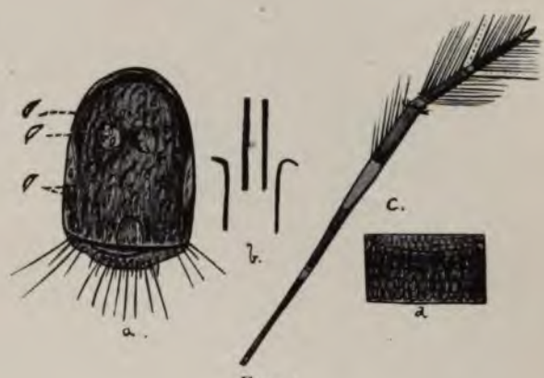
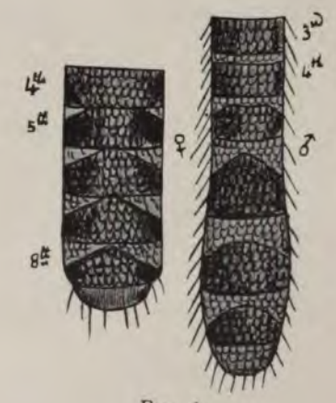


FIG. 4

FIG. 5



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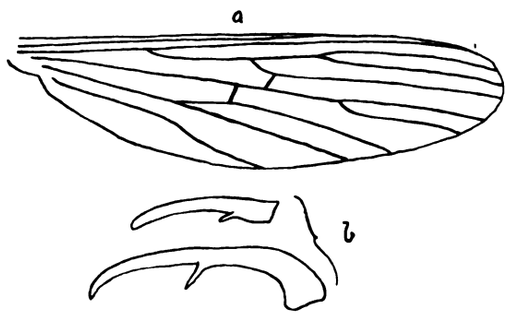
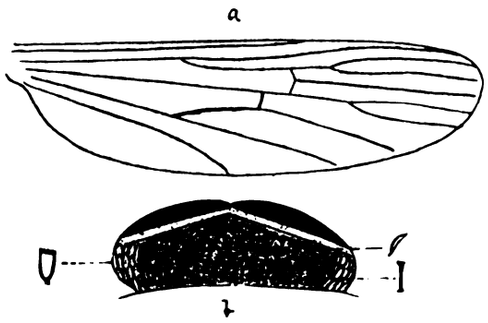


FIG. 7



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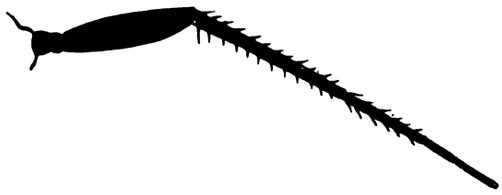
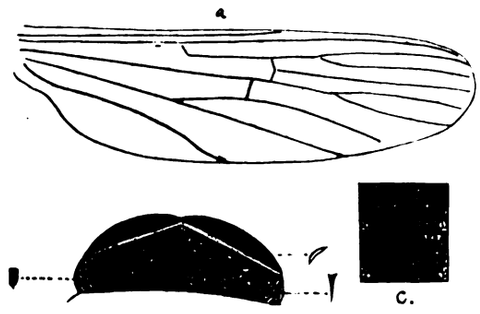


FIG. 9

a



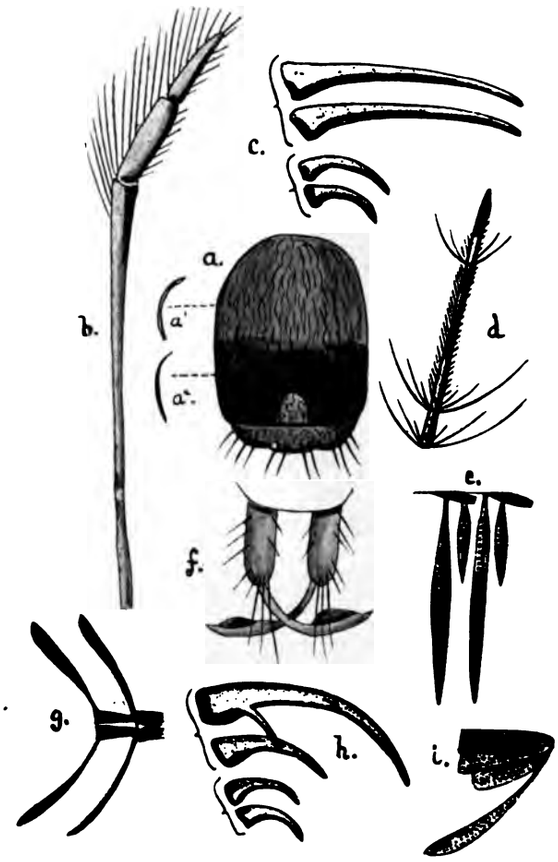


FIG. 14

DESCRIPTION OF PLATES

PLATE I

FIG. 1. *Filaria cypseli.* Nov. sp. ♂ and ♀: natural size.

FIG. 2. *F. cypseli.* Nov. sp. Head end of ♀. *a*, alimentary tract; *b*, oesophagus; *c*, opposite vaginal orifice; *d*, uterus full of ova; *e*, vagina. The nerve collar is indicated by the dark band across the anterior portion of the oesophagus.

FIG. 3. *F. cypseli.* Tail end of ♀. *a*, position of anus; *b*, uterus.

FIG. 4. *F. cypseli.* Head end of ♂. *a*, oesophagus; *b*, intestine.

FIG. 5. *F. cypseli.* Tail end of ♂. The worm has been ruptured near the extreme end, where the body contents are extruded. *a*, alimentary tract; *b*, opposite position of anal orifice; *c*, spermatic tube; *d*, spicules.

PLATE II

FIG. 1. *Filaria spiralis avium.* Nov. sp. ♂ and ♀: natural size.

FIG. 2. *F. spiralis avium.* Anterior end of ♀, and portion of first spiral. *a*, alimentary tract; *b*, oesophagus; *c*, opposite the position of vaginal orifice; *d*, uterus; *e*, vagina.

FIG. 3. *F. spiralis avium.* Posterior end of ♀, and portion of last spiral. *a*, alimentary canal; *b*, opposite the anal orifice, which is seen to be surrounded by five delicate lips, giving a rosette appearance; *c*, the lateral ridge as seen in the concavities of the coils; *d*, uterus, full of ova.

FIG. 4. *F. spiralis avium.* Posterior end of the ♀, side view; *a*, alimentary canal; *b*, opposite the position of anal orifice: seen here as a baying in the cuticle; *c*, the lateral cuticular ridge as seen on the convexities of the spirals; *d*, uterus.

FIG. 5. *F. spiralis avium.* The embryo: stained specimen of the blood (× 250). The dark spots round the worm are the nuclei of the red corpuscles. The sheath of the worm is distinctly shewn both at the head and tail ends of the worm.

PLATE III

FIG. 1. *Filaria spiralis avium.* Tail end of ♂ shewing its shape; *a*, opposite the position of the anal orifice; *b*, alimentary tract; *c*, spermatic tube.

FIG. 2. *F. spiralis avium.* Shews the spicular arrangement of the male. The two spicules are seen extruded through the wide crater-like anal orifice, situated on a low papilla. Behind is indicated the lateral cuticular flange which here comes to the ventral surface, to form with the one of the other side a sort of hollow cone at the bottom of which is the anal orifice.

PLATE IV

FIG 1. *Filaria fusiformis avium.* Nov. sp. ♂ and ♀: natural size.

FIG 2. *F. fusiformis avium.* Anterior end of ♀ shewing its shape, and *a*, the position of the vaginal orifice.

FIG 3. *F. fusiformis avium.* Posterior end of ♀ shewing its shape; *a*, alimentary tube; *b*, near the termination of the uterine tube.

FIG. 4. *F. fusiformis avium.* The embryos: a specimen of stained blood shewing the embryos inside, partly and completely out of their sheaths, also an empty sheath. The position of some of the 'spots' is also seen (× 350).

PLATE V

FIG. 1. *Filaria spiralis major avium.* Nov. sp. ♀ and ♂: natural size.

FIG. 2. *F. spiralis major avium.* Anterior end of ♀. *a*, opposite the anal orifice; *b*, uterus; *c*, vagina.

FIG. 3. *F. spiralis major avium.* Tail end of ♀. *a*, opposite the anal orifice. The cuticular knobs are well seen on the convexities of the spirals.

FIG. 4. *F. spiralis major avium.* Anterior end of ♂. *a*, oesophagus; *b*, alimentary canal; *c*, spermatic tube.

FIG. 5. *F. spiralis major avium.* The strongly incurved tail of the ♂. *a*, opposite the position of the anal orifice and spicules.

PLATE VI

FIG. 1. *Filaria spiralis major avium.* The embryo in a specimen of stained blood, shews the position of some of the 'spots' and the characteristic wire nail shaped posterior end (× 250).

FIG. 2. *F. shekletonii.* Nov. sp. The embryo in a specimen of stained blood. The position and characters of the 'spots' are well marked, as well as the sharply pointed tail (× 250).

FIG. 3. *F. shekletonii.* ♀: natural size.

FIG. 4. *F. shekletonii.* Head end of ♀. *a*, oesophagus; *b*, the alimentary tract; *c*, opposite vaginal orifice; *d*, uterus.

FIG. 5. *F. shekletonii.* The posterior end of ♀. *a*, intestine; *b*, opposite anal orifice; *c*, uterus.

PLATE VII

FIG. 1. *Filaria falciformis.* Nov. sp. ♂ and ♀: natural size.

FIG. 2. *F. falciformis.* Nov. sp. Head end of ♀. *a*, oesophagus; *b*, intestinal canal; *c*, opposite vaginal orifice; *d*, vagina; *e*, uterus.

FIG. 3. *F. falciformis.* Tail end of ♀. *a*, position of anal orifice; *b*, ovary; *c*, uterus; *d*, the corrugated cuticle.

FIG. 4. *F. falciformis.* Head end of ♂. *a*, oesophagus; *b*, intestine; *c*, opposite position of nerve collar crossing the oesophagus.

FIG. 5. *F. falciformis.* Tail end of ♂ shewing the spicules *a* and *b* extruded through the wide anal orifice; *c*, papillae; *d*, base of spicules.

PLATE VIII

FIG. 1. *Filaria falciformis.* Tail end of ♂ shewing spicular arrangement not extruded; numerous spermatozoa are seen.

FIG. 2. *F. falciformis.* The embryo in a specimen of stained blood; shews the characteristic 'spot' (× 250).

FIG. 3. *F. bibulbosa.* Nov. sp. ♂ and ♀ : natural size.

FIG. 4. *F. bibulbosa.* Head end of ♀. *a*, intestinal tract; *b*, oesophagus; *c*, opposite vaginal orifice; *d*, uterus; *e*, vagina.

FIG. 5. *F. bibulbosa.* Tail end of ♀; *a*, opposite anal orifice; *b*, intestine; *c*, distal end of ovary.

PLATE IX

FIG. 1. *Filaria bibulbosa.* Head end of ♂; *a*, intestinal canal; *b*, oesophagus; *c*, spermatic tube.

FIG. 2. *F. bibulbosa.* Tail end of ♂; note the single extruded spicule.

FIG. 3. *F. bibulbosa.* The embryos in stained blood. Specimen shewing their comma-shape and 'spots' (× 250).

PLATE X

FIG. 1. *Filaria capsulata.* Nov. sp. ♂ and ♀ and cyst containing worms : natural size.

FIG. 2. *F. capsulata.* The cyst with ♀ worm enclosed were highly magnified. The ♂ had been removed.

FIG. 3. *F. capsulata.* Head end and portion of the body of ♀; *a*, oesophagus; *b*, intestine; *c*, opposite vaginal orifice; *d*, vagina; *e*, uterine horn.

FIG. 4. *F. capsulata.* Tail end of ♀; *a*, intestine; *b*, opposite anal orifice.

FIG. 5. *F. capsulata.* The embryo in stained blood preparation (× 250).

PLATE XI

FIG. 1. *Filaria capsulata.* The ♂ complete. *a*, oesophagus; *b*, intestine; *c*, spermatic tube; *d*, tail end; *e*, head end.

FIG. 2. *F. capsulata.* Tail end of ♂. *a*, opposite anus and single partly extruded spicule; *b*, intestine; *c*, head end of ♂; *d*, head end of ♀.

FIG. 3. *F. phoenicopteri.* Nov. sp. ♂ : natural size.

FIG. 4. *F. phoenicopteri.* Head end of ♂. *a*, oesophagus; *b*, opposite oral orifice.

FIG. 5. *F. phoenicopteri.* Tail end of ♂ shewing single spicule extruded. *a*, intestine.

PLATE XII

FIG. 1. *Filaria serpentiformis.* Nov. sp. The embryo in stained blood preparation (× 250).

FIG. 2. *F. opobensis.* Nov. sp. The embryo in stained blood preparation (× 350).

FIG. 3. *F. calabarensis.* Nov. sp. The embryo in stained blood preparation (× 250).

PLATE XIII

FIG. 1. *Filaria cypseli.* Embryo with sheath—fresh specimen (× 550).

FIG. 2. *F. spiralis avium.* Embryo with sheath—fresh specimen (× 550).

FIG. 3. *F. fusiformis avium.* Embryo, and its head ending showing prepuce, papilla, and spine protruded and retracted (× 550).

FIG. 4. *F. spiralis major.* Embryo and sheath (× 550).

FIG. 5. *F. falciformis.* Embryo (× 550).

FIG. 6. *F. bibulbosa.* Embryo (× 550).

PLATE XIV

FIG. 7. *Filaria capsulata.* Embryo (× 550).

FIG. 8. *F. serpentiformis.* Embryo (× 550).

PLATE XV

FIG. 1. Transverse section of proboscis of the female *Anopheles costalis* near its tip (× 460). *lr-ep*, labrum-epipharynx; the two portions are shewn separated by a thin red transverse band; *h*, hypopharynx, with salivary canal at its centre; *m*, mandible; *mx*, maxilla; *lb*, labella; *t*, tip of labium; *fh*, superior region of inner surface of labella from which arises a feltwork of fine hairs; *ch*, inferior region of inner surface from which coarse hairs arise; *r*, a ridge of thickened chitin on the middle region of the inner surface, which above at its base enters into the articulation of the labella and labium.

FIG. 2. Transverse section of proboscis at the level of the labella joints (× 460). *lr-ep*, *h*, *m*, *mx*, as in fig. 1; *mx.p*, maxillary palp; *l*, lateral pear-shaped area at extremity of labella; *ln*, nerve to the labella; *a*, chitinous articulating surface of the labium; *k*, triangular area, occupied by a loose delicate membrane hanging from beneath the portion of the upper chitinous surface of the labium, which is prolonged to the extreme tip of the proboscis. In the section, the cut edge of the membrane is shewn as an irregular line. In this figure the labrum is not represented.

FIG. 3. Transverse section about the level of the middle of the proboscis (× 460). *lr-ep*, *h*, *m*, *mx*, *mx.p.* as in figs. 1 and 2; *l*, labium; *l.tr*, trachea to the labium; *l.n*, nerve to the labium; *r*, lateral chitinous ridge of the labium; *l.m*, labellar muscles. In this figure the labrum is not represented.

PLATE XVI

FIG. 1. Transverse section at the base of the proboscis of the female *Anopheles costalis* (× 460). *lr*, labrum; *ep*, epipharynx; *ep.r*, lateral supporting chitinous ridge of the epipharynx containing core of chitin forming cells; *h*, hypopharynx with salivary gutter; *m*, mandible; *mx*, maxilla; *mx.p*, maxillary palp; *o'*, a concave region on the inner surface of the maxillary palp, against which the mandible fits, indicating the relation of its origin; *o''*, a similar region for the maxilla; *p.m*, muscle of the maxillary palp; *l*, labium, note the shape at this level as compared with sections, plate xv, fig. 3; *r* lateral chitinous ridge of labium; *l.tr*, labial trachea; *ln*, labial nerve.

FIG. 2. Transverse section of proboscis just before the separation of the various mouth parts from each other (× 400). *c*, clypeus; *f*, upper posterior angle of the fulcrum; *lr*, proximal extremity of labrum, note the cubical cells; *lr.p*, chitinous prolongation of the labium within the clypeus; *em*, epipharyngeal muscle; *ep*, epipharynx; *h*, hypopharynx, the apex of the salivary receptacle is seen below, supported by two lateral chitinous bars; *m*, mandible; *mx*, maxilla, note its sickle shape; *mx.p*, maxillary palp; *pn*, nerve to maxillary palp; *pm*, muscle to the maxillary palp; *l*, labium; *ln*, labial nerve; *ltr*, labial trachea; note the line of cleavage of the labium from the other mouth parts.

PLATE XVII

FIG. 1. Transverse section of the head of *Anopheles costalis*, at the level of the middle of the ascending portion of the pharynx (× 360). *p*, ascending portion of the pharynx; *pd*, middle membranous portion of the upper wall of the pharynx, consisting of a layer of low cubical epithelium; *pv*, lower chitinous plate of the pharynx; *pm*, pharyngeal muscle; *lbr.m*, fan-shaped labral muscle; *sd*, common salivary duct;

rm, muscle to the salivary receptacle; *mx.p'*, intercranial maxillary process; *zm*, muscle attaching maxillary process to the occipital region of head; *lm'*, muscle to base of labium; *ln*, nerve to the proboscis; *ltr*, trachea to the proboscis; *mm*, muscle to the base of the mandible.

Plate XVIII

Fig. 1. Semi-diagramatic sagittal section through the head and proboscis of the female *Anopheles costalis* (× 200). *lbr*, labrum; *ep*, epipharynx; *h*, hypopharynx; *l*, labium; *p'* ascending portion to the pharynx; *p''*, horizontal portion; *n*, nerve to the proboscis; *oe*, oesophagus; *tr*, trachea to the proboscis; *s.r*, salivary receptacle; *s.d*, common salivary duct; *f.m*, muscle to the salivary receptacle; *x*, chitinous ridge or under surface of ventral wall of the first part of the pharynx, from which *(f.m)* the muscle to the salivary receptacle arises; *c*, clypeus; *p.m*, pharyngeal muscle; *lbr.m*, labral muscle inserted into the prolongation of the labrum; *e.m*, epipharyngeal muscle arising from the fulcrum; *a*, commencement of the labrum: below this on the upper wall of the pharynx are the 'taste papillae'; *f*, fulcrum; *s.o.g*, supra-oesophageal ganglion; *i.o.g*, infra-oesophageal ganglion; *s.o*, specialized hairs; *mx.p*, intercranial maxillary process; *v.c*, ventral commissure; *d.v*, dorsal vessel; *d.t*, main trachea to the head; *e*, eye.

Fig. 2. Transverse section at the level of the junction of the first and second part of the pharynx shewing the group of specialized hairs (× 530). *p*, pharynx; *z*, that part of the exoskeleton which is folded in beneath the eyes.

Plate XIX

Fig. 1. Semi-diagramatic longitudinal horizontal section of the head and proboscis of the female *Anopheles costalis* (× 180). *bm*, muscle to the pumping organ, the middle membranous portion of the pharynx; *zm*, muscle attaching the maxillary process to the occipital region of the skull; *ltr*, trachea and nerve to the proboscis; *lm'*, muscle to the base of the labium, arising from the under surface of the maxillary process; *rm*, muscle to the salivary receptacle; *sr*, salivary receptacle and duct; *s*, V-shaped opening of salivary receptacle; *h*, hypopharynx, the salivary gutter runs along its centre; *mx.p*, maxilliary palp; *lm*, origin of labellar muscle; *mx.p'*, intercranial process of the maxilla; *e*, eye,

Fig. 2. Section of the distal end of the labium and labellae (× 410). *lm*, labellar muscle; *lm'*, longitudinal tendon of labellar muscle; *r*, lateral chitinous ridge of the labium, from which the labellar muscles arises; *a*, chitinous process at the base of the labella into which the long tendon of the labellar muscle is inserted; *lb*, labella; *ln*, the termination of the labellar nerve; *g*, ganglionic structure in the interior of the labella, shewing the fibres of the labellar nerve ramifying over its surface; *ch*, coarse hairs projecting downwards between the labellae and arising from their inner surface.

Fig. 3. Drawing of a cleared specimen of the distal end of the labium and of the labellae of the female *Anopheles costalis* (× 390). *lb*, labella; *l*, labium; *g*, groove on the upper surface of the labium in which the stylets are enclosed; *a*, the labellae articulation, observe the angle for the insertion of the long tendon of the labellar muscle; *r*, lateral chitinous ridge of labium; *tl*, tip of the labium.

FIG. 1

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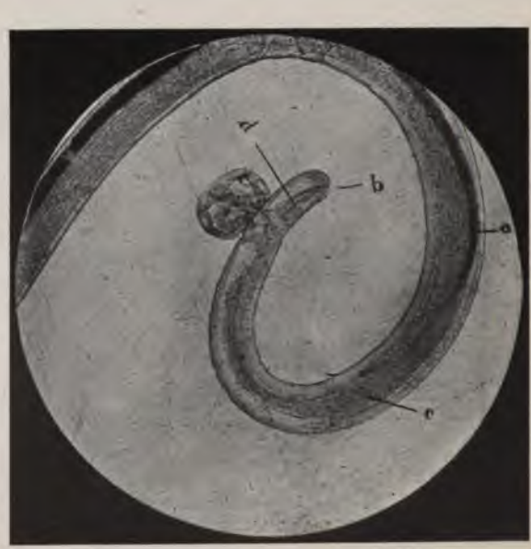
FIG. 4



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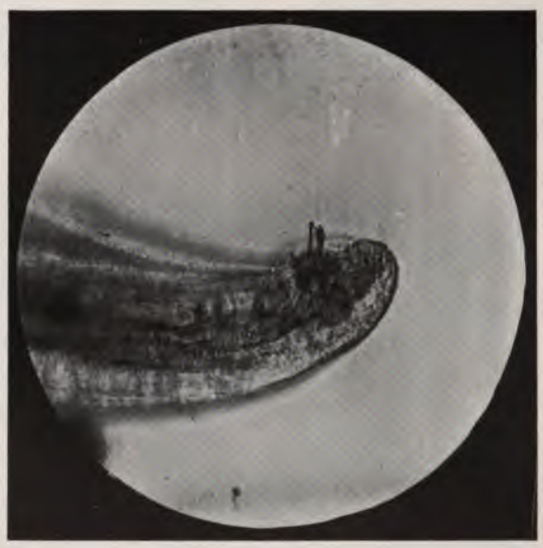

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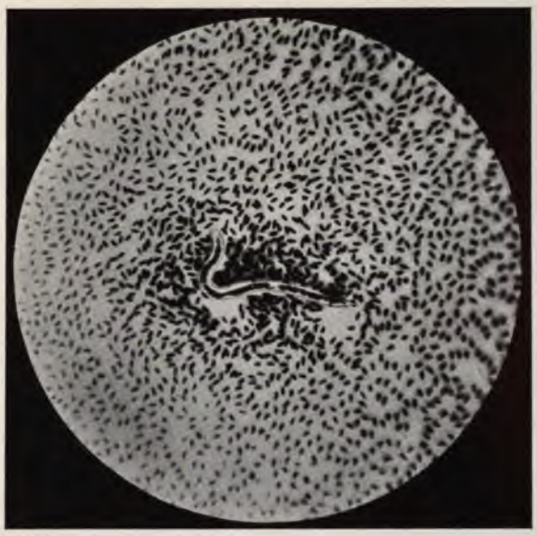

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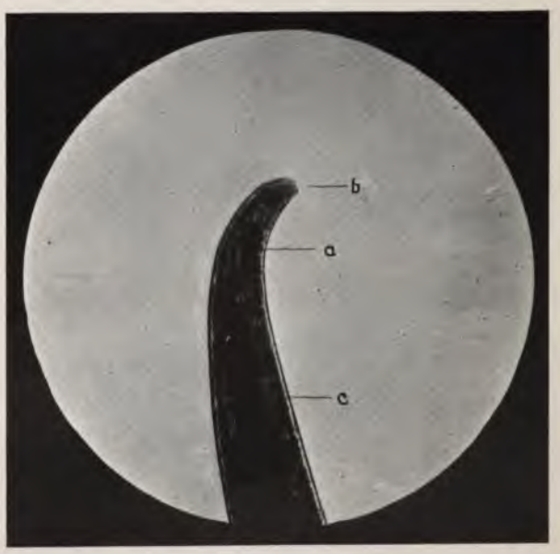
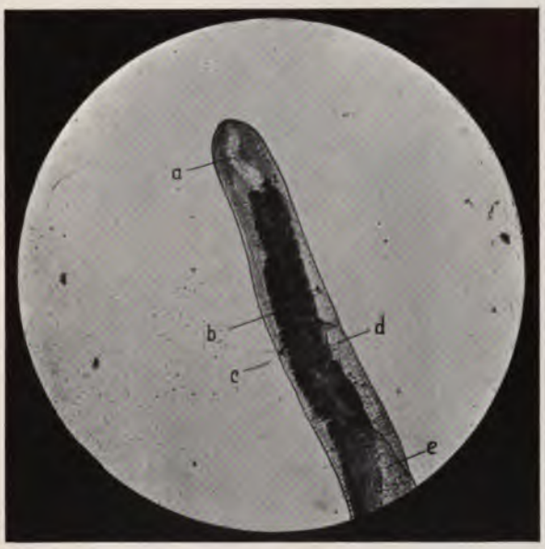


FIG. 5

FIG. 1



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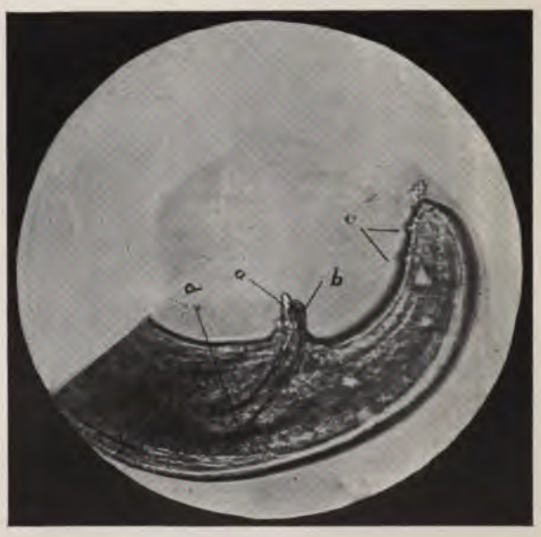
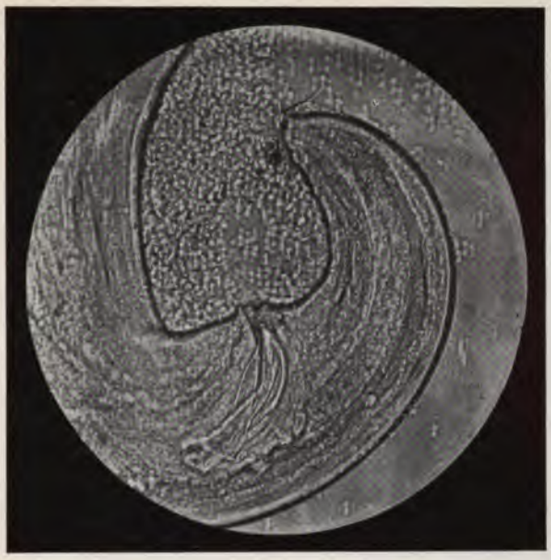


FIG. 5



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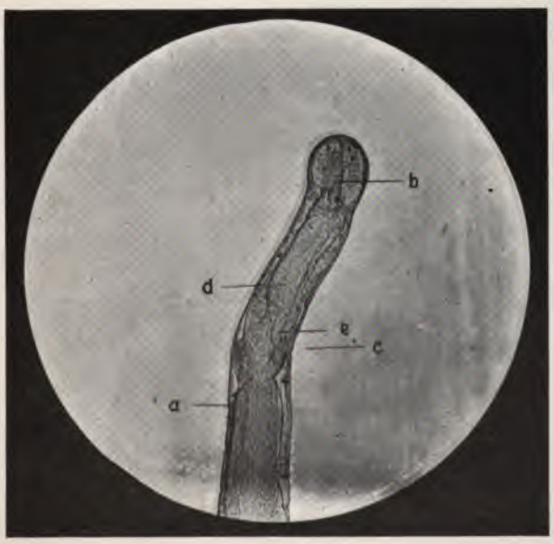

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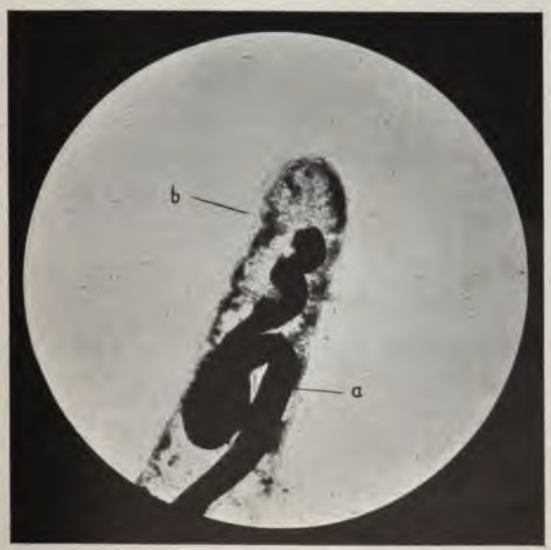

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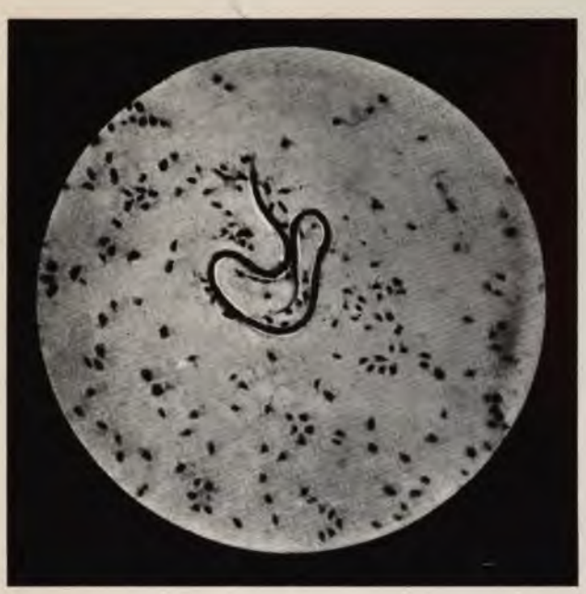

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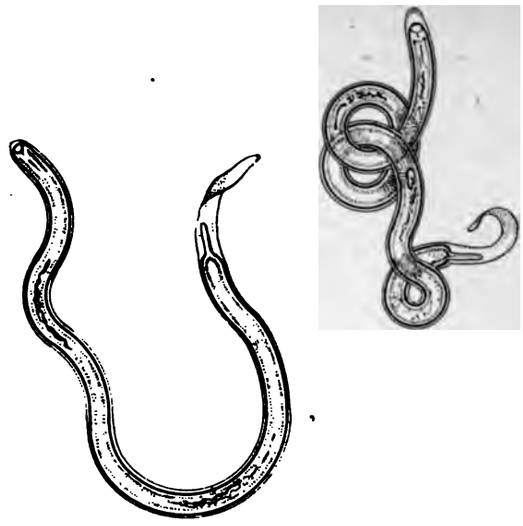

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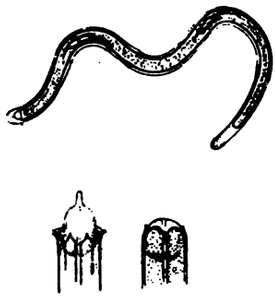


Fig. 3.

Fig. 4.

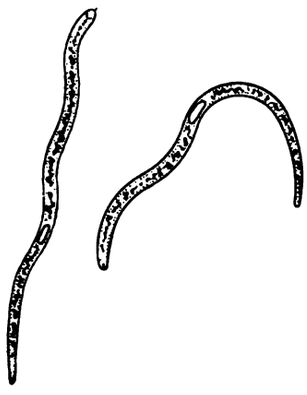
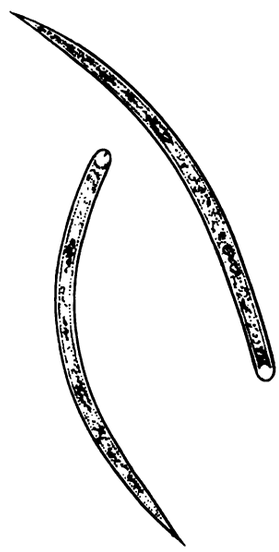


Fig. 5.



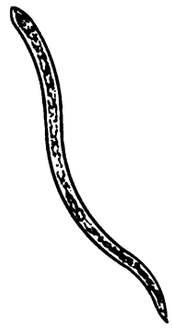


Fig. 7.

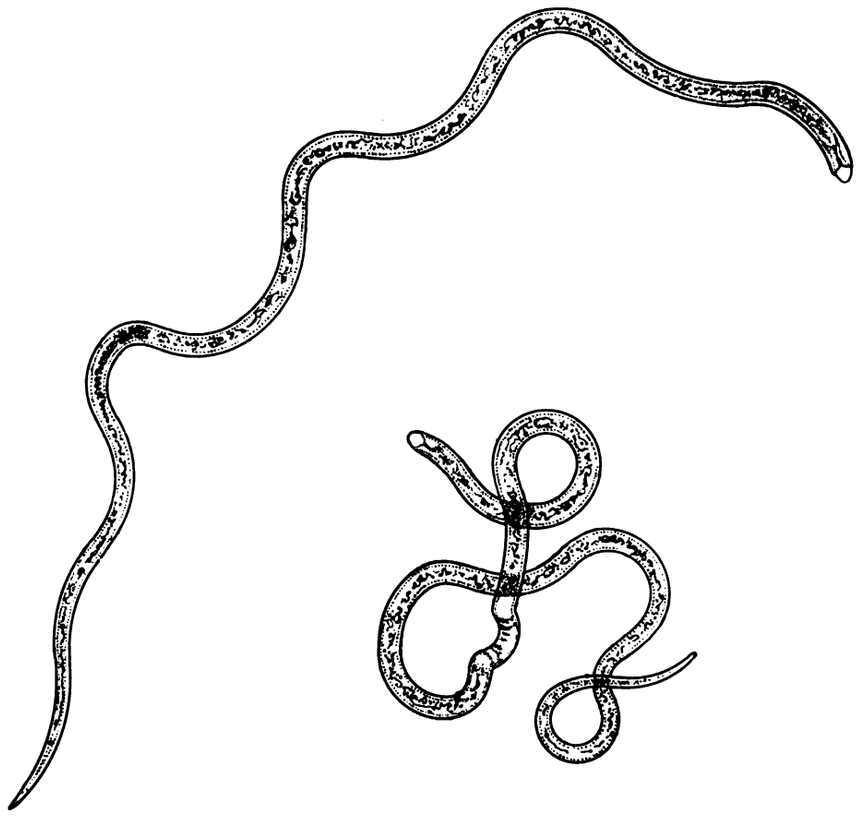


Fig. 8.

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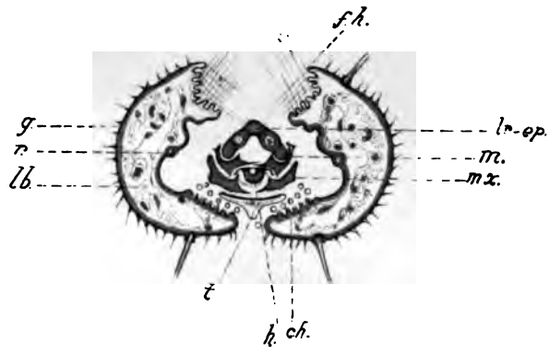
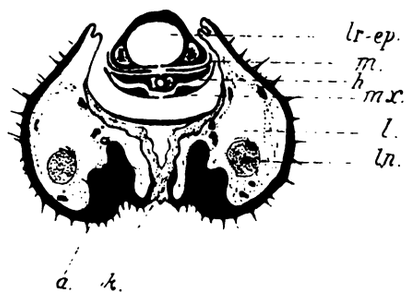


Fig 1.



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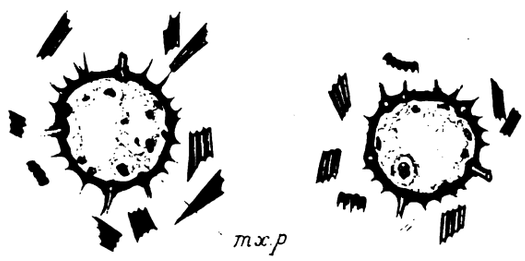


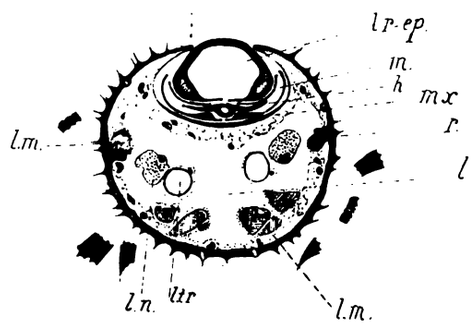
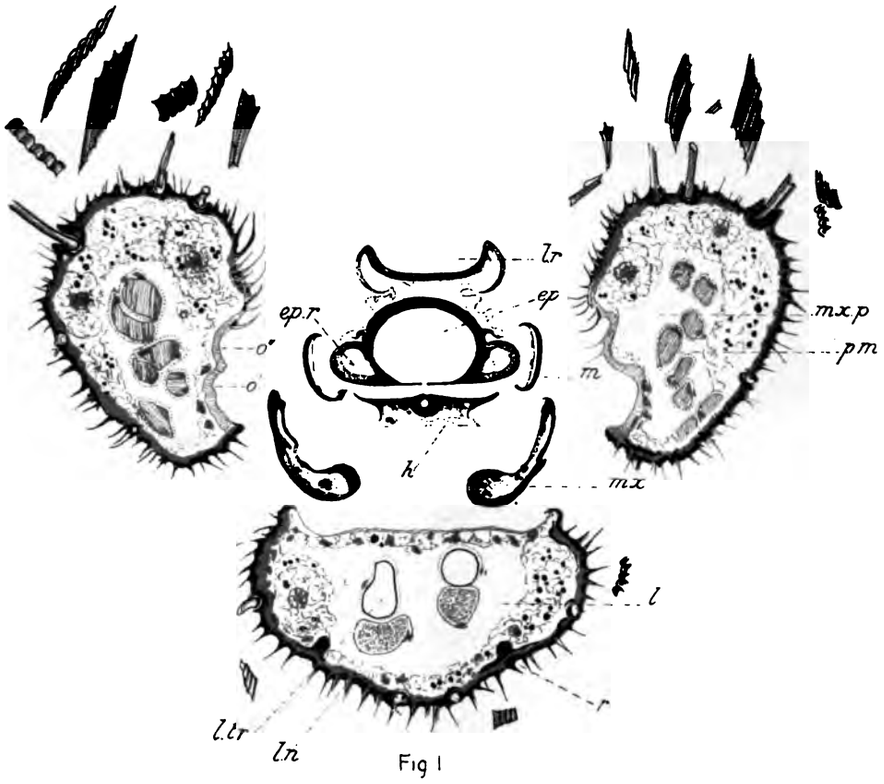


Fig 3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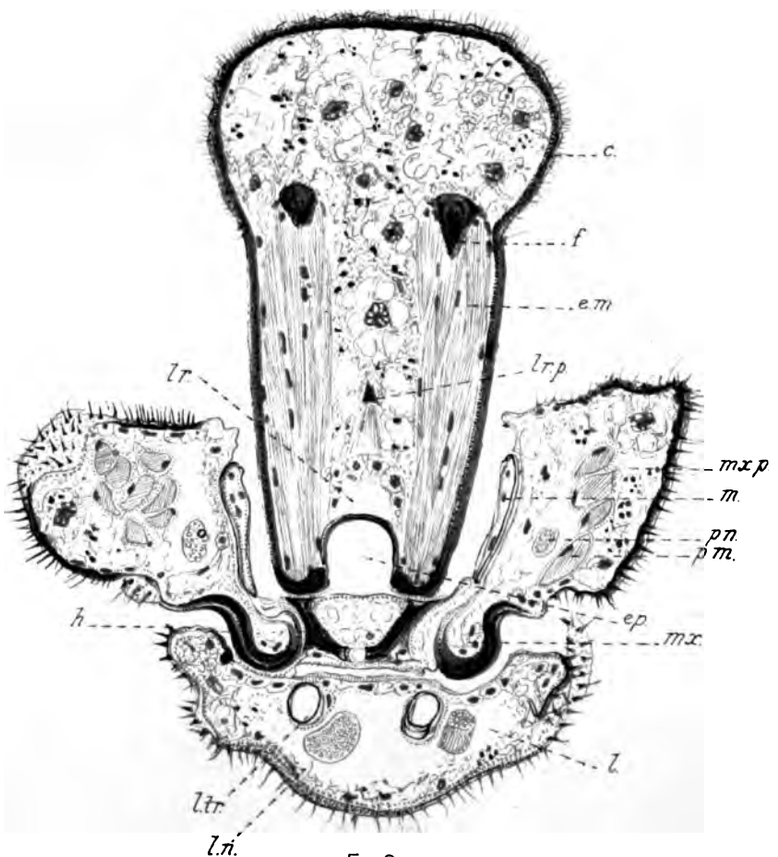
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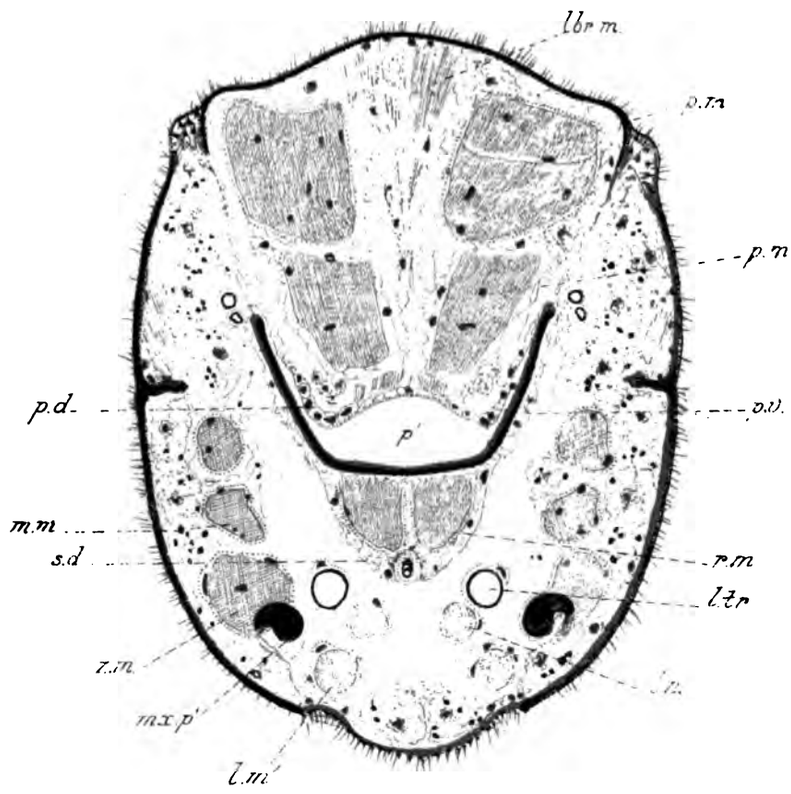
Fig 2.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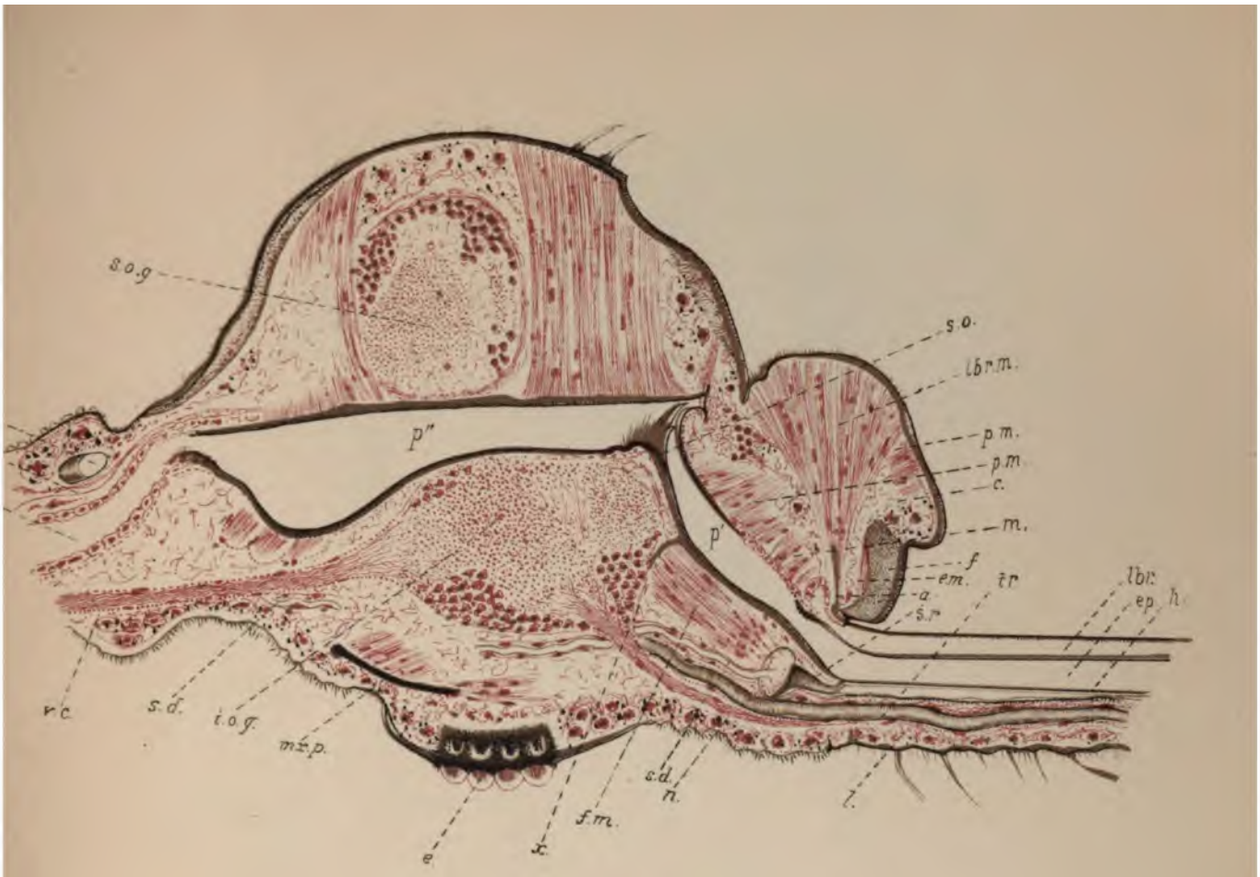
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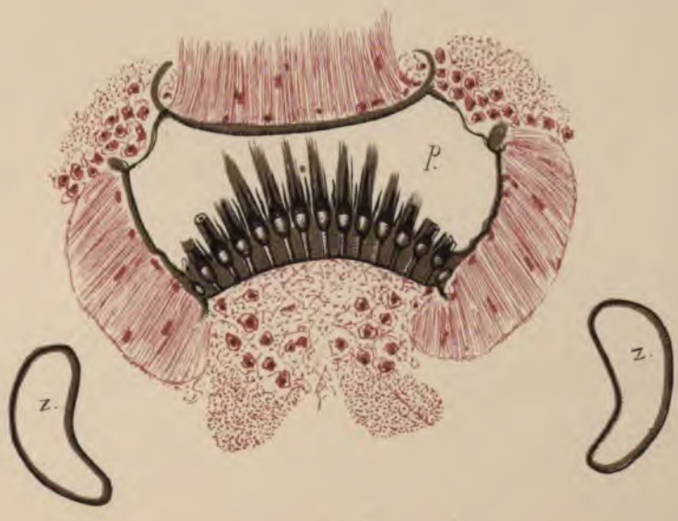
FIG 1.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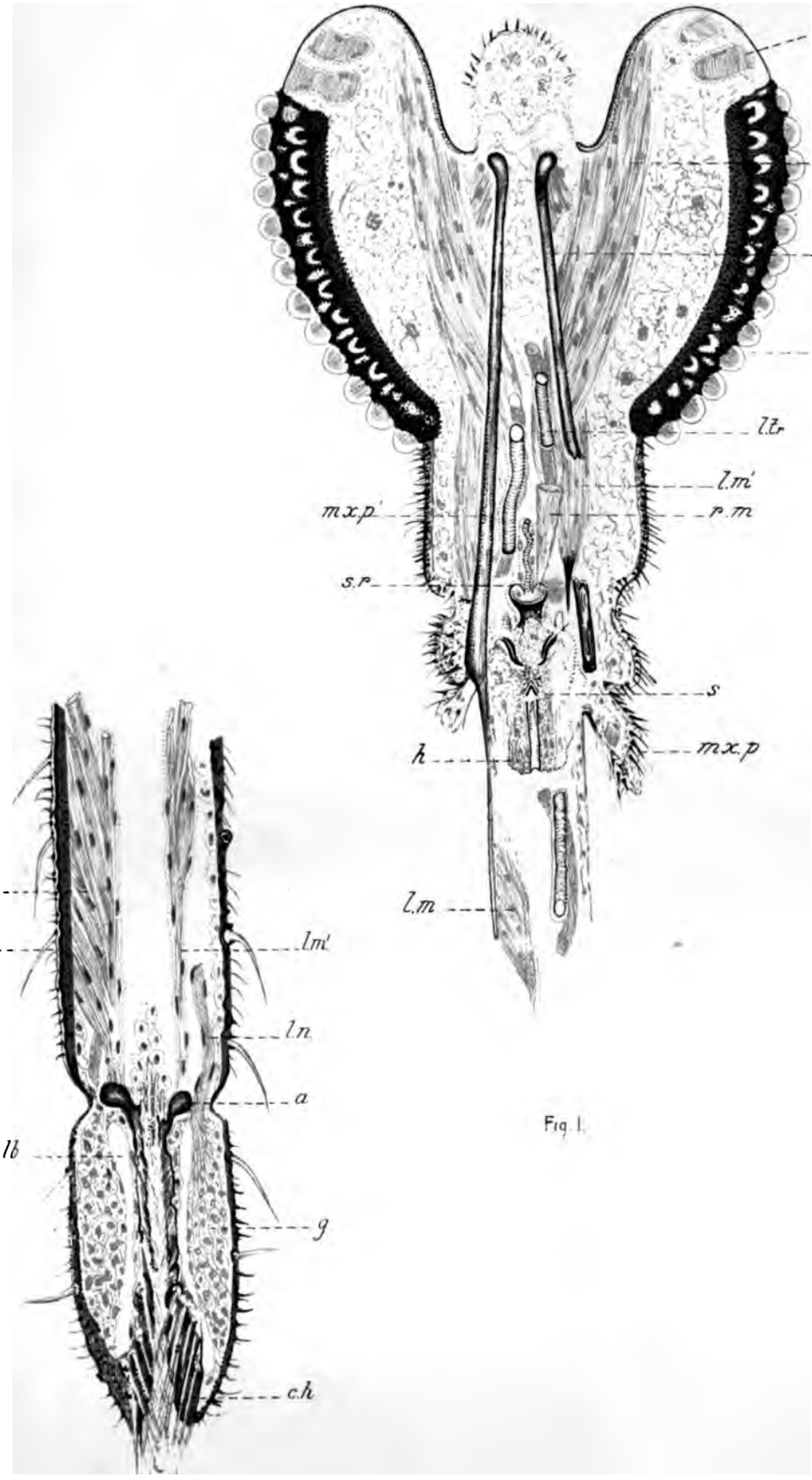

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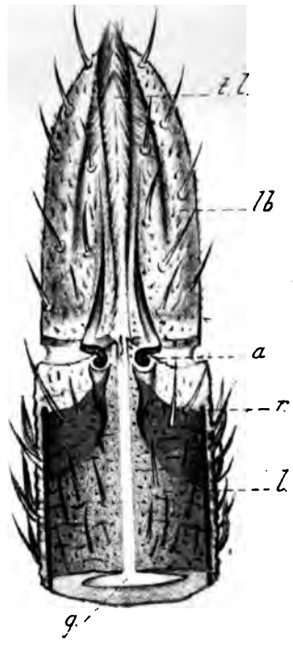

Fig 3.

BIBLIOGRAPHY

BIBLIOGRAPHY

COMPLETE LIST OF FILARIAE*

I. Larval Forms

Name	Literature	Host	Site
	(*a*) Mammalia		
F. diurna. Manson	See chapter iv	*Homo sapiens*	See chapter iv
F. perstans. Manson	" "	*Homo sapiens*	" "
F. vesperuginis. Linstow	Linstow. Arch. f. Naturg, li, 1885, p. 243	*Vesperugo scrotinus* (Hameln)	In long oval cysts in the intestinal wall
F. irritans. Rivolta	Railliet. Zool. medic. et agric., Paris, 1893, p. 508	*Equus caballus. Equus asinus*	See chapter ii
	(*b*) Aves		
F. gruis. Linstow	Linstow. Arch. f. Naturg., xli, 1875, p. 197	*Ciconia alba*; *Grus cinerea*	Encysted either in stomach or intestinal wall
F. strigis. Linstow	Linstow. Arch. f. Naturg., xliii, 1877, p. 176; xlv, 1879, p. 173; xlvi, 1880, p. 45; xlviii, 1882, p. 1; li, 1885, p. 244	*Buteo vulgaris* (Hameln) *B. lagopus* (Hameln) *Otus vulgaris* (Hameln) *Nisus communis* (Hameln) *Astur palumbarius* (Hameln) *Bubo maximus* (Hameln) *Surnia noctua* (Hameln) *Strix flammea* (Hameln) *Surnia ulula* (Hameln) *Lanius excubitor* (Hameln)	
	(*c*) Pisces		
F. bicolor. Linstow	Linstow. Arch. f. Naturg., xxxix, 1873, p. 298	*Silurius glanis* (Hameln)	Under the peritoneal layer of stomach
	(*d*) Arthropoda		
F. stomoxeos. Linstow	Linstow. Arch. f. Naturg., xli, 1875, p. 195	*Stomoxys calcitrans* (Hameln)	In the proboscis
F. ephemeridarum. Linstow	Linstow. Arch. f. Mikr. Anat. xxxix, 1892, p. 396	*Ephemera vulgata* (Göttingen) *Oligoneura rhenana* (Göttingen)	
F. geotrupis. Linstow	Linstow. Arch. f. Mikr. Anat., xlviii, 1896, p. 375	*Geotrupis sylvaticus* (Göttingen)	
F. glomeridis. Linstow	Linstow. Arch. f. Naturg., li, 1885, p. 243	*Glomeris limbata* (Hameln)	
F. pulicis. Linstow	Linstow. Jena. Zeitsch, xxviii, 1893, p. 340	*Gammarus pulex* (Göttingen)	
F. gammari. Linstow	Linstow. Arch. f. Mikr. Anat., xxxix, 1892, p. 325	*Gammarus pulex* (Göttingen)	

II. Oral Aperture without Lips

	(*a*) Mammalia		
F. bancrofti. Cobbold	See chapter iv	*Homo sapiens*	See chapter iv
F. loa. Guyot	See chapter iv	*Homo sapiens*	See chapter iv
F. lentis. Diesing	Diesing. Syst. Helm., ii, 1851, p. 265 Molin. Wien. Sitzber, xxviii, 1858, p. 390 Diesing. Wien. Sitzber, xlii, 1860, p. 702 Cobbold. Entoz. London, 1864, p. 332 De Bonis. Paras. d. corpo umano, Napoli, 1876, p. 129 Davaine. Traité d. Entoz., Paris, 1877, p. 106 Küchenmeister et Zürn. D. Paras d. Mensch, Leipzig, 1881, p. 429 Railliet. Zool. med. et agric., Paris, 1893, p. 529	*Homo sapiens* (Berlin)	See chapter ii
F. labialis. Pane	Pane. Ann Accad. d. Aspiranti Natur., Naples, 1864, p. 32 Davaine. Traité d. Entoz., Paris, 1877, p. cvii Küchenmeister u. Zürn. Paras d. Mensch, Leipzig, 1881, p. 430 Railliet. Zool. med. et agric., Paris, 1893, p. 530 Parona. Elminth italiana, Genova, 1894, p. 239	*Homo sapiens* (Naples)	See chapter ii

* From Stossich, *Filarie e Spiroptere.* Trieste, 1897.

NAME	LITERATURE	HOST	SITE
F. medinensis. Gmelin	Gmelin. Syst. Natur., 1878, p. 3039 Rudolphi. Entoz. Synops., 1819, p. 3 Lamark. Anim. s. vert., iii, 1840, p. 667 Dujardin. Hist. Nat. d. Helm., 1845, p. 44 Diesing. Syst. Helm., ii, 1851, p, 269 Baird. Catal. of Entoz., London, 1853, p. 5 Molin. Wien. Sitzber, xxviii, 1858, p. 403 Schneider. Monogr. d. Nemat, 1866, p. 85 De Bonis. Paras. d. corpo umano, Naples, 1876, p. 128 Davaine. Traité d. Entoz., Paris, 1877, p. cvii Küchenmeister u. Zürn. D. Paras. d. Mensch, Leipzig, 1881, p. 417 Zürn. Thier. Paras. uns. Haussaüget, Weimar, 1882, p. 249 Blanchard. Anim. Paras., introd. par l'eau, Paris, 1890, p. 71 Railliet. Zool. med. et agric., Paris, 1893, p. 500 Parona. Elminthol italiana, Genova, 1894, p. 239	*Homo sapiens* (Arabia, Persia, Turkestan, India, Guinea, Senegambia, Darfur, Sennaar, Abyssinia, Nubia, Egitto, Curacao, Brazil); *Bos taurus*, *Equus caballus* (India); *Canis familiaris* (Egitto, Buenos Ayres, Curacao, India); *Canis lupaster*: *C. aureus*: *Felis catus*, *F. guttata* (Kordofan)	See chapter ii
Syn. *F. aethopica*	Valenciennes. Compt. rend Acad. Sc., xliii, 1856, p. 259 Molin. Wien. Sitzber, xxviii, 1838, p. 373		
Dracunculus persarum	Diesing. Wien. Sitzber, xlii, 1860, p. 686 Diesing. Wien. Sitzber, xliii, 1861, p. 286 Huber. Bibliogr. I. klin. Helminth, München, 1894, p. 245		
Dracunculus aethiopicus	Diesing. Wien. Sitzber, xlii, 1860, p. 698		
Dracunculus medinensis	Cobbold. Entoz., London, 1864, p. 373 Sonsino. Pr. Verb. d. Soc. Toscana d. sc. nat., 12 mag., 1889		
F. lymphatica. Treutler Syn. *F. hominis bronchialis*	Railliet. Zool. med. et. agric., Paris, 1893, p. 530 Rudophi. Entoz. Synops., 1819, p. 7 and 215 Dujardin. Hist. Nat. d. Helm., 1845, p. 45 Diesing. Syst. Helm. ii, 1851, p. 279 Molin. Wien. Sitzber. xxviii, 1858, p. 418	*Homo sapiens* (Sicily) *Equus caballus* (Milan) *Equus asinus*	See chapter *ii*
F. apapillocephala	Condorelli. Roma, 1892		
F. conjunctivae	Addario. Ann. d. ottalmolog., xiv, 1885 Condorelli. Filar. apapill. Roma, 1892		
F. dubini	Condorelli. " " " "		
F. inermis	Grassi. Centr. f. Bakt. u Par. I, 1887, p. 617 Calundruccio. Anim. Paras. dell' uomo in Sicilia, 1889, p. 19 Railliet. Zool. medic. et agric. Paris, 1893, p. 528 Parona. Elmintol. italiana. Genova, 1894, p. 239		
F. oculi	Quadri. Cpt. rend. d. Congres. Ophthal. d. Bruzel., 1858, p. 153.		
F. oculi asini	Condorelli. Filar. apapill. Roma, 1892		
F. palpebralis	Pace. Giorn. d. sc. nat. ed. econ. Palermo, ii, 1866, p. 152 Condorelli. Filar. apapill. Roma, 1892		
F. palpebrarum	De Bonis. Paras. d. corpo. umano. Napoli, 1876, p. 130		
F. peritonaei hominis	Babesius. Arch. f. path. Anat. u. Physiol., 1880, p. 158 Condorelli. Filar. apapill. Roma, 1892		
Hamularia lymphatica	Treutler. Observ. Path. Anat., 1793, p. 10		
Tentacularia subcompressa	Zeder. Naturg. d. Eingw., 1803, p. 45		
F. lacrymalis. Gurlt	Gurlt. Pathol. Anat., i, 1831, p. 347 Gerber. Handb. d. allg. Anat., 1840, p. 211 Diesing. Syst. Helm. ii, 1851, p. 265 Molin. Wien. Sitzber. xxviii, 1858, p. 372 Diesing. Wien. Sitzber., xlii, 1860, p. 701 Moroni. Il. medico. veterinario. Torino, 1864, April Davaine. Traité d. Entoz. Paris, 1877, p. 109 Zürn. Thier Paras. uns Haussäuget. Weimar., 1882, p. 248 Perroncito. I parass. dell'uomo e. d. anim. Milano, 1882, p. 32 Railliet. Zool. med. et agric. Paris, 1893, p. 527 Parona. Elmintol. italiana. Genova, 1894, p. 241	*Bos taurus*, *Equus caballus*	See chapter ii
F. recondita. Grassi	Grassi e. Calundruccio. Centr. f. Bakt. u. Paras. vii, 1890, p. 18 Railliet. Zool. med. et agric. Paris, 1893, p. 573 Parona. Elmintol. italiana. Genova, 1894, p. 241	*Canis familiaris* (Catania)	See chapter ii
F. palpebralis. Wilson	Railliet. Zool. med. et agric. Paris, 1893, p. 528	*Equus caballus*	See chapter ii
F. nasicola. Leuchart Syn. *Spiroptera nasicola*	Baird. Catal. of Entoz. London, 1853, p. 5 Dujardin. Hist. Nat. d. Helm, 1845, p. 88 Diesing. Syst. Helm., ii, 1851, p. 225	*Mustela foina*; *M. putorius*	In frontal and ethmoid sinuses
F. acutiuscula. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 388 Stossich. Boll. Soc. Adriat. di Sc. Nat., xii, 1890, p. 56 Railliet. Zool. med. et agr. Paris, 1893, p. 508 Parona. Elmintol. italiana. Genova, 1894, p. 241	*Dicotyles albirostris* (Brazil); *D. torquatus* (Brazil); *Vulpus azarae*, *Canis familiaris* (Venice)	Between the viscera In the pectoral muscles

Name	Literature	Host	Site
F. hyalina. Linstow	Linstow. Arch. f. Naturg., 1890, p. 182	*Sorex vulgaris* (Gottingen)	Intestine
F. haemorrhagica. Railliet.	Railliet et Moussu. Compt. rend. d. l. Soc. d. Biolog., iv, 1892, p. 545	*Equus caballus* *Equus asinus*	See chapter ii
	Railliet. Zool. med. et agric. Paris, 1893, p. 505		
F. immitis. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 55	*Canis familiaris* (Europe, U.S.A., Brazil, Australia, Borneo, China, Japan); *C. lupus* (Japan); *C. vulpes*, *C. brachyucus*	In right heart, pulmonary arteries, and sometimes in other veins and arteries; occasionally free in thoracic cavity, in liver and subcutaneous and inter-muscular tissue
	Molin. Wien. Sitzber, xxviii, 1858, p. 384		
	Schneider. Monogr. d. Nematod., 1866, p. 87		
	Railliet. Journ. d. Veter. d. Midi., 1862, p. 49		
	De Silvestri. Il medico veterinario, ser. iii, vol. vi, 1871, p. 343		
	Ercolani. Mem. R. Acad. d. Sc. Bologna, series iii, tom. v, 1874, p. 390		
	Lewis. Quart. Journ. of micr., s. xv, 1875, p. 268		
	Davaine. Traité d. Entoz. Paris, 1877, p. 108		
	Rivolta. Giorn. Anat. fisiol. patol. anim., dom. ix, 1879, p. 17		
	Leidy. Proc. Acad. Nat. Sc., Philadelphia, 1880, p. 10		
	Zürn. Thier. Paras. uns Haussäuget. Weimar, 1882, p. 243		
	Megnin. Journ. d. l'Anat., xix, 1883, p. 172		
	Blanchard. Bull. Soc. Zool. di France, xii, 1887		
	Parona. Elmíntol. sarda. Genova, 1887, p. 86		
	Sonsino. Sugli ematozoi del. cane. Pisa, 1888		
	Railliet. Zool. med. et agric. Paris, 1893, p. 509		
	Parona. Elmintol. italiana. Genova, 1894, p. 240		
	Ward. The paras. worms of man and the dom. anim., 1894, p. 319		
	Parona. Boll. d. Musei d. R. Univ. d. Genova, 1896, n. 43		
	Galli-Valerio. Moderna Zooiatro, 1897		
Syn. *F. canis cordis*	Leidy. Proc. Acad. Nat. Sc. Philadelphia, v, 1853, p. 118		
F. papillicauda	Molin. Wien. Sitzber, xxviii, 1858, p. 380		
" "	Diesing. Wien. Sitzber, xlii, 1860, p. 701		
F. flexuosa. Wedl	Wedl. Wien. Sitzber, xix, 1852, p. 122	*Cervus elaphus* (Vienna)	In subcutaneous tissues
	Molin. Wien. Sitzber, xxviii, 1858, p. 386		
	Linstow. Württemb. naturw. Jahreshefte, 1879, p. 328		
F. crassicauda. Creplin	Creplin. Nov. Act. Nat. Cur., xiv, 1829, p. 874	*Balaenoptera rostrata* (Rugen) *Balaena mysticetus*	In the corpus cavernosus of the penis
	Dujardin. Hist. Nat. d. Helm, 1845, p. 50		
	Diesing. Syst. Helm., ii, 1851, p. 264		
	Molin. Wien. Sitzber, xxviii, 1858, p. 374		
	Beneden. Bull. Acad. Roy. Bruxelles, ser. ii, tom. xxix, 1870, p. 356		
F. quadrispina. Diesing	Diesing. Syst. Helm., ii. 1851, p. 271	*Mustela martes* (Pavia) *M. foina* (Trieste, Cittanova in Istria, Padua, Genova), *M. putorius* (Padua), *Hystrix cristata* (Senaat), *Gulo barbatus* (Brazil), *Galictis barbara*	Under the skin, in the pericardial sac; in the cavity of the abdomen
	Schneider. Monog. d. Nemat, 1866, p. 85		
	Stossich. Boll. Soc. Adriat. di Sc. Nat. Trieste, vii, 1890, p. 56 ; xiv, 1893, p. 85 ; xvii, 1896, p. 122		
Syn. *F. perforans*	Molin. Wien. Sitzber, xxviii, 1858, p. 387		
	Molin. " " xxx, 1858, p. 155		
	Diesing. " " xlii, 1860, p. 700		
	Molin. Denkschr. Wien. Akad., xix, 1861, p. 316		
	Diesing. Wien. Sitzber, xliii, 1861, p. 280		
	Parona. Ann. Museo. civico di Genova, 1887, p. 495		
	Parona. Elmintol. italiana. Genova, 1894, p. 240		
	Parona. Boll. d. Musei d. Univ. Torino, xi, 1896, n. 258		
F. martis	Gmelin. Syst. Nat. Lipsiae, 1788, p. 3040		
	Zeder. Naturg. d. Eingew., 1803, p. 38		
F. mustelarum subcutanea	Rudolphi. Entoz. Synops., 1819, p. 7 and 216		
F. australis. Linstow	Linstow. Arch. f. Mikr. Anat., xlix, 1897, p. 610	*Petrogale penicillata* (Australia)	Visceral cavity

(*b*) Aves

F. calamiformis. Schneider	Schneider. Monogr. d. Nemat., 1866, p. 90	*Psitacus aestivus* (Brazil)	Above the tendons of the feet
F. mazzantii. Railliet.	Railliet. Zool. med. et agric. Paris, 1893, p. 532	*Columba domestica*	Under the skin of the neck
F. schneideri. Stossich			
F. obtusocaudata	Schneider. Monogr. d. Nemat., 1866, p. 101	*Falco subbuteo* (Berlin)	Stomach
F. urogalli. Linstow	Linstow. Württemb. Naturw. Jahresh, 1879, p. 325	*Tetrao urogallus*	Under the skin
F. mansoni. Cobbold	Magalhães. Revista Brazil d. Medicina, i, 1888, p. 5	*Gallus domesticus* (China, Rio Janeiro)	Orbital cavity
	Railliet. Zool. med. et agric., Paris, 1893, p. 533		
	Magalhães. Bull Soc. Zool. de France, xx, 1895, p. 241		

NAME	LITERATURE	HOST	SITE
F. foveolata. Molin	Molin. Wien. Sitzber, xxviii, 1852, p. 375 Linstow. Arch. f. Naturg., xlv., 1879, p. 172 Stossich. Hist. Natur., Croat, vi, 1891, p. 217 Stossich. Hist. Natur., Croat, vii, 1892, p. 72	*Circus cyaneus* ; *Falco peregrinus* (Trieste, Venice, Hameln) ; *F. lanarius* ; *F. lithofalco* ; *Nisus communis* (Venice); *Corvus frugilegus* (Switzerland) ; *Thamnophilus stagurus* (Brazil)	In pleural and abdominal cavities
F. nodulosa. Rudolphi	Diesing. Syst. Helm., ii, 1851, p. 274 Molin. Wien. Sitzber, xxviii, 1858, p. 409 Schneider. Monogr. d. Nemat., 1866, p. 91 Linstow. Arch. f. Naturg., xlix, 1883, p. 287 „ Vermi. Mosca, 1886, p. 12 Leidy. Proc. Acad. Nat. d. Sc. Philadelphia, 1886, p. 309 Parona. Elmintol. sarda Genova, 1887, p. 87 „ Ann. Museo civico di Genova, 1887, p. 495 Stossich. Boll. Soc. Adriat. di sc. Nat. Trieste, xii, 1890 „ Soc. Hist. Nat. Croat., vii, 1892, p. 72 „ Boll. Soc. Adriat. di Sc. Nat. Trieste, xiv, 1893 Parona. Elmintol. italiana. Genova, 1894, p. 242 Stossich. Boll. Soc. Adriat. di sc. Nat. Trieste, xvii, 1896, p. 122	*Lanius collurio* (Trieste, Venice, Berlin, Turkestan) ; *L. rufus* (Cagliari, Genova) ; *L. auricul..tus* (Cagliari, Genova) ; *L. minor* ; *Collurio lodovicianus* (Florida)	Under the skin of the cranium and back, and in oesophageal wall
Syn. *Tentacularia cylindrica* *F. collurionis pulmonalis* „ *subcutanea*	Zeder. Naturg. d. Eingw., 1803, p. 45 Rudolphi. Entoz. Synops., 1819, pp. 8 and 217 „ „ „ 1819, pp. 8 and 217		
F. obtusocaudata. Rudolphi	Rudolphi. Entoz. Synops., 1819, p. 634 Dujardin. Hist. Nat. d. Helm., 1845, p. 55 Diesing. Syst. Helm., ii, 1851, p. 277 Molin. Wien Sitzber, xxviii, 1858, 413 Linstow. Württemb. naturw. Jahresh., 1879, p. 327 „ Arch. f. Naturg., xlix, 1883, p. 284 „ Vermi. Mosca, 1886, p. 10 Parona. Ann. Museo civico di Genova, xxvii, 1889, p. 762	*Lanius rufus* ; *L. minor* ; *Pernix leucostriata* ; *Picus flavescens* ; *P. robustus* ; *P. lineatus* ; *P. passerinus* ; *P. aurulentus* ; *P. leucolaemus* ; *P. iumana*	In the muscles of the neck, and in the thoracic cavity
Syn. *Monopetalonema obtuse-caudatum*	Diesing. Wien. Sitzber, xlii, 1860, p. 710		
F. spermospizae. Linstow.	Linstow. Arch. f. Naturg., xlv, 1879, p. 171	*Spermospiza guttata*	Internal cavities
F. bhamoensis. Parona	Parona. Ann. Museo civico di Genova, 1890, p. 777	*Acridotheres albocinctus* (Birmania)	In abdominal cavity
F. paronai. Stossich Syn. *F. sp.*	Parona. Ann. Museo civico di Genova, 1885, p. 433	*Buceros nasutus* (Soudan)	Kidney
F. sp.	Linstow. Arch. f. Naturg., 1891, p. 300		
F. ecaudata. Örley	Örley. Ann. Mag. of Nat. Hist., 1882, p. 312 Linstow. Arch. f. Naturg., 1891, p. 300	*Lamprotornis aeneus*	
F. clava. Wedl	Wedl. Wien. Sitzber, xix, 1856, p. 126 Molin. Wien. Sitzber, xxviii, 1858, p. 374 Diesing. Wien. Sitzber, xlii, 1860, p. 701 Ralliet. Zool. med. et agric. Paris, 1893, p. 532	*Columba domestica*	See chapter ii
F. tricuspis. Fedtschenko	Linstow. Arch. f. Naturg., xlix, 1883, p. 285 Linstow. Vermi. Mosca, 1886, p. 10 Linstow. Arch. f. Naturg., 1891, p. 293 Stossich. Boll. Soc. Adriat. di sc. nat. Trieste, xvii, 1896, p. 122	*Corvus cornix* (Venice, Padua, Vienna, Turkestan) ; *C. corone* (Vienna), *C. frugilegus* (Padua, Trieste, Vienna) ; *C. corax* (Vienna);	Abdominal cavity
Syn. *F. unguiculata*	Rudolphi. Entoz. Synops., 1819, pp. 4 and 209 Dujardin. Hist. Nat. d. Helm., 1845, p. 54 Diesing. Syst. Helm., ii, 1851, p. 267 Molin. Wien. Sitzber, xxviii, 1858, p. 378	*C. monedula* (Vienna) ; *Pyrrhocorax alpinus* (Vienna); *Pica caudata* (Vienna) ; *Garrulus glandarius* (Vienna);	
F. monticelliana	Stossich. Soc. Hist. Nat. Croat., v, 1890, p. 130	*Nucifraga caryocatactes* (Vienna);	
F. ninnii	Stossich. Soc. Hist. Nat. Croat., vi, 1891, p. 217	*Sturnella ludoviciana* ;	
F. alaudae	Zeder. Natur. d. Eingw., 1803, p. 39	*Sylvia atricapilla* (Zagabria); *Poecile palustris* (Zagabria) ; *Corvus cyanomelas* ; *Hirundo rustica* ; *Alauda arvensis* (Trieste) ; *Lullula arborea* (Trieste) ; *Acridotheres tristis* (East Indies) ; *A. ginginianus* (East Indies)	
F. flabellata. Linstow	Linstow. Zool. of the voyage of H.M.S. Challenger, vol. xxiii, part lxxi, London, 1888, p. 9 Linstow. Arch. f. Naturg., 1891, 300 Parona. Ann. Museo civico di Genova, 1890, p. 777	*Paradisea apoda* (Aru Island) ; *Cyanops ramsayi* (Tenasserim)	Subcutaneous, and in internal cavities
F. pungens. Schneider	Schneider. Monogr. d. Nemat., 1866, p. 92 Linstow. Arch. f. Naturg., 1891, p. 300	*Turdus cyaneus* (Argo)	
F. obtusa. Rudolphi	Zeder. Naturg. d. Eingw., 1803, p. 36 Rudolphi. Entoz. Synops., 1819, p. 4 Dujardin. Hist. nat. d. Helm., 1845, p. 53 Diesing. Syst. Helm., ii, 1851, p. 267 Baird. Catal. of Entoz. London, 1853, p. 6 Molin. Wien. Sitzber, xxviii, 1858, p. 397 Diesing. „ „ xlii, 1860, p. 702	*Hirundo rustica* (Vienna, Greifswald, Rennes) ; *H. urbica* (Genova, Vienna, Turkestan) ; *H. riparia* (Vienna) ; *H. versicolor* (Brazil) ; *Progne purpurea* ; *Myothera caudacuta*	Abdominal cavity

Name	Literature	Host	Site
F. obtusa. Rudolphi—contd.	Linstow. Arch. f. Naturg., xlix, 1883, p. 286 Linstow. Vermi. Mosca, 1886, p. 11 Parona. Ann. Museo civico di Genova, 1887, p. 495 Linstow. Arch. f. Naturg., 1891, p. 300 Parona. Elmintol italiana. Genova, 1894, p. 242		
F. turdi atrogularis. Linstow	Linstow. Arch. f. Naturg., xlix, 1883, p. 288 Linstow. Vermi. Mosca, 1886, p. 13	*Turdus atrogularis* (Turkestan)	
	(*c*) Reptilia		
F. macrophallos. Parona	Parona. Ann. Museo civico d. Genova, 1890, p. 778	*Hydrosaurus salvator* (Birmania)	Between the abdominal muscles
F. emmae. Stossich Syn. *F. sp.*	Parona. Ann. Museo civico di Genova, 1890, p. 778	*Catotes emma* (Burmah)	
F. dahomensis. Neumann	Neumann. Bull. Soc. Zool. de France, xx, 1895, p. 123	*Python natalensis* (Dahomey)	In the subcutaneous tissue of the abdominal wall
	(*d*) Pisces		
F. denticulata. Rudolphi Syn. *Cochlus inermis* *Liorhynchus denticulatus*	Schneider. Monog. d. Nemat., 1866, p. 102 Zeder. Naturg. d. Eingw., 1803, p. 50 Rudolphi. Entoz. Synops, 1879, pp. 62 and 307 Bremser. Icon. Helminth, 1824 Lamark. Anim. s. vert., iii, 1840, p. 646 Dujardin. Hist. Nat. d. Helm., 1845, p. 284 Diesing. Syst. Helm. ii, 1851, p. 247	*Anguilla vulgaris*	Stomach
F. echinata. Linstow	Linstow. Arch. f. Naturg., xliv, 1878, p. 235	*Alburnis lucidus* (Hameln)	Intestine
F. obturans. Prenant	Prenant. Bull. Soc. sc. Nancy (2), vii, 1888, p. 215	*Esox lucius* (Nancy)	Bronchial artery

III. Buccal cavity has no lips, but is surrounded by a chitinous ring

(*a*) Mammalia

F. equina. Abildgaard Syn. *F. equi* *F. papillosa*	Blanchard. Ann. d. Sc. Nat., ser. iii, tom. xi, p. 154 Railliet. Zool. med. et agric. Paris, 1893, p. 524 Neumann. Revue vétérin, xxii, 1897, p. 75 Gmelin. Syst. Natur., 1789, p. 3039 Zeder. Naturg. d. Eingw., 1803, p. 37 Anderson. Edinb. Medic. and Surg. Journal, ii, 1805, p. 306 Sick. Med. Jahrb. d. k. k. österr. Staat, ii, 1813, p. 174 Greve. Krankh. d. Hausth., 1818, p. 174 Rudolphi. Entoz. Synops., 1819, pp. 6 and 213 Bremser. Vers intest. d. l'hom, 1824, p. 123 Bremser. Icon. Helminth, 1824 Gurlt. Path. Anat. i, 1831, p. 348 Nordmann. Microgr. Beiträge, 1832, p. 11 Siebold. Arch. f. Naturg., 1837, p. 255 Lamark. Anim. s. vert., iii, 1840, p. 668 Dujardin. Hist. Nat. d. Helm., 1845, p. 49 Diesing. Syst. Helm., ii, 1851, p. 272 Baird. Catal. of Entoz. London, 1853, p. 5 Wedl. Wien. Sitzber, xvii, 1855, p. 307; xix, 1856, p. 56 Leidy. Proc. Acad. Nat. Sc., Philadel., viii, 1856, p. 55 Molin. Wien. Sitzber, xxviii, 1858, p. 405 Schneider. Monogr. d. Nematod., 1866, p. 86 Panizza. Il medico veterinario. Torino, 1869, p. 193 Davaine. Traité d. Entoz. Paris, 1877, p. cix Zürn. Their. Paras. uns. Haussäuget. Weimar, 1882, p. 242 Lange. Deutsch. Zeitschr. f. Thier medicin, viii, 1882, p. 71 Linstow. Arch. f. Naturg., xlix, 1883, p. 284 Linstow. Vermi. Mosca, 1886, p. 9 De Silvestri. Giorn. d. medic. veterin. prat. Torino, xxxvi, 1887, p. 429 Blanchard. Bull. Soc. Zool. France, xii, 1887 Parona. Ann. Museo civico di Genova, 1887, p. 494 Deupser. Zool. Anzeiger, 1892, n. 388 Parona. Elmintol. italiana. Genova, 1894, p. 241	*Equus caballus* (Italy); *E. asinus* (Milan); *E. mulus*; *Bos taurus*; *B. bubalus*	In peritoneal cavity, testicle, pleural cavity, lungs, between the meninges, in liver, aqueous humour
F. bubali	Rudolphi. Entoz. Synops., 1819, p. 8 Molin. Wien. Sitzber, xxviii, 1858, p. 421		
F. strumosa. Rudolphi Syn. *Spiroptera strumosa*	Schneider. Monog. d. Nematod., 1866, p. 103 Linstow. Arch. f. Naturg., 1885, p. 241 Linstow. Zool. Jahrb., iii, 1887, p. 112 Rudolphi. Entoz. Synops, 1819, pp. 24 and 241 Dujardin. Hist. Nat. d. Helm., 1845, p. 86 Diesing. Syst. Helm., ii, 1851, p. 213 Baird. Catal. of Entoz. London, 1853, p. 2	*Talpa europaea* (Padua, Sondrio, Rennes, Vienna, Halle, Hameln, Greifswald, Ireland) (Larval form encysted in fat bodies of *Cetonia aurata*)	Stomach and intestines, and in pedunculated tumours on external coat of stomach

Name	Literature	Host	Site
F. strumosa. Rudolphi—contd.	Molin. Wien. Sitzber, xxx, 1858, p. 152; xxxviii, 1859, p. 933		
	Diesing. Wien. Sitzber, xlii, 1860, p. 677		
	Molin. Denkschr. Wien. Akad., xix, 1861, p. 300		
	Parona. Elmintol. italiana. Genova, 1894, p. 246		
	Galli-Valerio. Moderno Zooiatro, 1897		
Ascaris talpae	Gmelin. Syst. Nat., p. 3032		
Fusaria convoluta	Zeder. Naturg. d. Eingw., 8803, p. 106		
Spirura talpae	Blanchard. Ann. d. Sc. Nat., ser iii, tom. xi, p. 162		
F. labiato-papillosa. Alessandrini	Alessandrini. Nuovi annali. di sc. nat. Bologna, i, 1838, p. 1	*Bos taurus*; *Cervus elaphus*; *C. columbianus*; *C. virginianus*; *C. capreolus*; *C. rufus*; *C. nambi*; *C. simplicicornis*	Peritoneal cavity
	Perroncito. I paras. dell'uomo e d. anim. Milano, 1882, p. 326		
	Railliet. Zool. med et agric. Paris, 1893, p. 526		
	Parona. Elmintol italiana. Genova, 1894, p. 241		
	Galli-Valerio. Moderno Zooiatro, 1897		
Syn. *F. cervi*	Rudolphi. Entoz. Synops, 1819, p. 8		
F. cervina	Dujardin. Hist. Nat. d. Helm, 1845, p. 49		
F. terebra	Diesing. Syst. Helm., ii, 1851, p. 274		
	Molin. Wien. Sitzber, xxviii, 1858, p. 405		
	Diesing. Wien. Sitzber, xlii, 1860, p. 703		
	Schneider. Monogr. d. Nemat., 1866, p. 86		
	(*b*) Aves		
F. dehiscens. Schneider	Monogr. d. Nemat., 1866, p. 91	*Strix striata* (Dongola)	
F. brasiliana. Stossich			
Syn. *P. insignis*	Schneider. Monogr. d. Nematod., 1866, p. 91	*Picus sp.* (Brazil)	Under the skin of the neck
F. foveata. Schneider	Schneider. Monogr. d. Nemat., 1866, p. 90	*Otus brachyotus* (Brazil)	
F. labiata. Creplin	Blanchard. Ann. d. Sc. Nat., ser. iii, tom., xi, p. 157	*Ciconia nigra* (Greifswald, Posan, Paris, Venice, Pavia, Umbria); *C. alba*	Thoracic and abdominal cavities
	Nathusuis. Arch. f. Naturg., iii, 1837, p. 53		
	Siebold. Arch. f. Naturg., 1838, p. 292		
	Dujardin. Hist. nat. d. Helm., 1845. p. 57		
	Diesing. Syst. Helm., ii, 1851, p. 276		
	Molin. Wien. Sitzber, xxviii, 1858, p. 414		
	Schneider. Monogr. d. Nematod, 1866, p. 89		
	Stossich. Boll. Soc. Adriat. di sc. Nat. Trieste, xii, 1890, p. 56		
	Parona. Elmintol italiana. Genova, 1894, p. 243		
	Condorelli. Boll. Soc. romana per gli studi zoolog., iv., 1895, pp. 93 and 208		
Syn. *F. ardeae nigrae*	Rudolphi. Entoz. Synops., 1819, pp. 9 and 218		
	Dujardin. Hist. Nat. d. Helm., 1845, p. 57		
	Diesing. Syst. Helm., ii, 1851, p. 282		
	Molin. Wien. Sitzber, xxviii, 1858, p. 428		
	Parona. Elmintol italiana. Genova, 1894, p. 243		
F. ciconiae	Gmelin. Syst. Nat., p. 3040		
	Zeder. Naturg. d. Eingw., 1803, p. 39		
	Rudolphi. Entoz. Synops., 1819, p. 9		
	Dujardin. Hist. Nat. d. Helm., 1845, p. 57		
	Diesing. Syst. Helm., ii, 1851, p. 282		
	Molin. Wien. Sitzber, xxviii, 1858, p. 428		
	Parona. Elmintol italiana. Genova, 1894, p. 243		
Dicheilonema labiatum	Diesing. Wien. Sitzber, xlii, 1860, p. 708		
	IV. Buccal orifice with two lips		
	(*a*) Mammalia		
F. gastrophila. Mueller	Mueller. Arch. d. Naturg., lx, 1894, p. 113	*Felis domestica* (Bavaria)	In neighbourhood of end of oesophagus and cardia of stomach
F. radula. Schneider	Schneider. Monog. d. Nematod., 1866, p. 98	*Paradoxurus phillipinensis*	Stomach
	(*b*) Aves.		
F. horrida. Diesing	Diesing. Syst. Helm., ii, 1851, p. 278	*Rhea americana* (Brazil)	Stomach; thoracic and abdominal cavities, muscles, under the skin, and in ovum
	Diesing. Denkschr. Wien. Akad., 1857, p. 19		
	Molin. Wien. Sitzber., xxviii, 1858, p. 416		
	Schneider. Monog. d. Nemat., 1866, p. 89		
	Linstow. Arch. f. Naturg., xlvi, 1880, p. 46		
	Leidy. Proc. Acad. Nat. Sc. Philadelph., 1884, p. 47		
	Linstow. Arch. f. Mikr. Anat., xlix, 1897, p. 613		
Syn. *Dicheilonema horridum*	Diesing. Wien. Sitzber., xlii, 1860, p. 709		

Name	Literature	Host	Site
F. paradiseae. Linstow	Linstow. The Zool. of the voyage of H.M.S. Challenger, Entoz., 1888, p. 11	*Paradisea apoda* (Aru Island)	
F. tridentata. Linstow	Linstow. Arch. f. Naturg., xliii, 1877, pp. 10 and 175	*Colymbus arcticus* (Hameln) *Larus ridibundus*	Intestine Oesophagus
F. rotundata. Linstow	Linstow. Arch. f. Naturg., xlix, 1883, p. 283 Linstow. Vermi. Mosca., 1866, p. 8	*Otis macquini* (Turkestan)	
F. recta. Linstow	Linstow. Württemb. Naturw. Jahresh., 1879, p. 324	*Podiceps cristatus*	In stomach wall
F. coelebs. Linstow	Linstow. Württemb. Naturw. Jahresh., 1879, p. 326	*Lanius rufus*	In stomach wall
F. capitella. Schneider	Schneider. Monogr. d. Nematod., 1866, p. 96	*Coracius garrula*	In stomach wall
	(*c*) Pisces		
F. conoura. Linstow	Linstow. Arch. f. Naturg., li, 1885, p. 242	*Anguilla vulgaris* (Hameln)	Intestine

V. Buccal orifice with three or six lips

(*a*) Mammalia

F. ascaroides. Linstow	Linstow. Württemb. Naturw. Jahresh., 1879, p. 332	*Cercopitherus mona*	Bronchi
F. muris. Gmelin			
Syn. *Ascaris muris*	Gmelin. Syst. Nat., p. 3032	*Mus musculus* (Vienna, Galicia, Breslau, Griefswald, Berlin, Rennes) ; *Mus decamanus* (Brazil)	Stomach
Fusaria muris	Zeder. Naturg. d. Eingw., 1803, p. 106		
Filaria obtusa	Schneider. Monogr. d. Nemat., 1866, p. 97 Linstow. Arch. f. Naturg., xlix, 1883, p. 286 Kowalwski. Sitzber. Akad. Krakau, xxi, 1896, p. 257		
Spiroptera obtusa	Rudolphi. Entoz. Synops, 1819, pp. 27 and 249 Bremser. Vers. intest. de l'hom., 1824, p. 126 Bremser. Icon. Helminth, 1824 Lamark. Anim. s. Vert., iii, 1840, p. 661 Dujardin. Hist. Nat. d. Helm., 1845, p. 89 Diesing. Syst. Helm., ii, 1851, p. 214 Baird. Catal. of Entoz. London, 1853, p. 9 Molin. Wien. Sitzber, xxxviii, 1859, p. 934 Parona. Elmintol. italiana. Genova, 1894, p. 246		
F. verrucosa. Molin			
Syn. *Spiroptera verrucosa*	Molin. Wien. Sitzber, xxxviii, 1859, p. 964 Drasche. Zool. Botan. Gesell. Wien., xxxiii, 1884, p. 203	*Cervus dichotomus* (Brazil) ; *C. nambi* ; *C. paludosus*	Between the tendons of the phalanges

(*b*) Aves

F. obvelata. Creplin	Linstow. Arch. f. Naturg., xliii, 1877, p. 174 Parona. Elmintol. Sarda. Genova, 1887, p. 88 Braun. Arch. d. Fr. d. Naturg. i. M., 1891, p. 112 Stossich. Soc. Hist. Natur. Croat, vii, 1892, p. 72 Parona. Elmintol. italiana. Genova, 1894, p. 243	*Larus medius* ; *L. canus* (Warnemünde) ; *L. fuscus* ; *L. marinus* ; *L. ridibundus* (Cagliari, Trieste) ; *L. argentatus* ; *L. argentatoides* ;	Oesophagus and proventriculus
Syn. *Spiroptera obvelata*	Dujardin. Hist. Nat. d. Helm., 1845, p. 101	*L. maximus* (Griefswald) ;	
Histiocephalus spiralis	Diesing. Spst. Helm., ii, 1851, p. 231	*Mergus serrator* ; *Sterna risoria* ; *Totanus fuscus* (Hameln) ; *T. maculatus* ; *T. hypolencus* ; *Alca torda* ; *Ursa grylle*	
Cosmocephalus alatus	Molin. Wien. Sitzber, xl, 1860, p. 345 Diesing. Wien. Sitzber, xlii, 1860, p. 673		
F. phasiani picti. Molin.			
Syn. *Spiroptera phasiani picti*	Molin. Wien. Sitzber, xxxviii, 1859, p. 981 Drasche. Zool. Botan. Gesell. Wien., xxxiii, 1884, p. 206	*Phasianus pictus* (Vienna)	Stomach wall
F. tulostoma. Hempr. et Ehr.	Schneider. Monogr. d. Nemat., 1866, p. 102	*Neophron percnopterus*	Thorax
F. vulturis. Molin			
Syn. *Spiroptera vulturis*	Molin. Wien. Sitzber, xxxviii, 1859, p. 976 Drasche. Zool. Botan. Gesell. Wien., xxxiii, 1884, p. 205.	*Cathartes papa* (Brazil)	Between the muscles of the lower jaw
F. anolabiata. Molin			
Syn. *Spiroptera anolabiata*	Molin. Wien. Sitzber, xxxviii, 1859, p. 981 Drasche. Zool. Botan. Gesell. Wien., xxxiii, 1884, p. 206	*Crax fasciolata* (Brazil)	Under the nictitating membrane
F. leptoptera. Rudolphi	Schneider. Monogr. d. Nemat., 1866, p. 97 Linstow. Arch. f. Naturg., xliii, 1877, p. 10 Linstow. Wurttemb. Naturw. Jahresh., 1879, p. 325 Kowalewski. Sitzber Akad. Krakaw, xxxi, 1896, p. 256	*Milvus regalis* ; *M. ater* (Greifswald) ; *Accipites nisus* (Hameln, Ireland) ; *Circus cineraceus* (Vienna) ;	

Name	Literature	Host	Site
Syn. *Spiroptera leptoptera*	Rudolphi. Entoz. Synops., 1819, pp. 26 and 247 Dujardin. Hist. Nat. d. Helm, 1845, p. 93 Diesing. Syst. Helm., ii, 1851, p. 217 Baird. Catal. of Entoz. London, 1853, p. 10 Molin. Wien. Sitzber, xxxviii, 1859, p. 953	*C. cyaneus*; *C. rufus*; *Buteo vulgaris* (Vienna, Galicia, Berlin, Rennes); *Astur palumbarius*; *Herpetotheres cachinans* (Brazil); *Harpogus bidentatus* (Brazil); *Falco tinnenculus* (Vienna); *F. lanarius*; *F. albicollis*; *F. subbuteo* (Vienna); *F. aurantius* (Brazil); *F. magnirostris* (Brazil); *F. xanthothorax* (Brazil); *F. unicinctus* (Brazil); *F. tridentatus* (Brazil); *Emberiza pecoris* (Paris)	Oesophagus, stomach and intestine
F. guttata. Schneider	Schneider. Monogr. d. Nema., 1866, p. 92	*Falco borigera* (Adelaide)	Under the palpebral conjunctiva
F. attenuata. Rudolphi	Rudolphi. Entoz. Synops., 1819, pp. 4 and 208 Bremser. Vers intest. d. l'hom., 1824, p. 123 Bremser. Icon. Helminth., 1824 Blanchard. Ann. d. Sc. Nat., ser. iii, tom., xi, p. 156 Lamark. Anim. s. Vert., iii, 1840, p. 667 Ecker. Arch. f. Anat. u. Phys., 1845, p. 503 Dujardin. Hist. Nat. d. Helm., 1845, p. 50 Diesing. Syst. Helm., ii, 1851, p. 266 Baird. Catal. of Entoz. London, 1853, p. 6 Wedl. Wien. Sitzber., xvii, 1855, p. 308, xix, 1856, p. 57 Leidy. Proc. Acad. Nat. Sc. Philadelph., viii, 1856, p. 56 Molin. Wien. Sitzber, xviii, 1858, p. 394; and xxx, 1858, p. 155 Diesing. Wien. Sitzber., xlii, 1860, p. 702 Molin. Denkschr. Wien. Akad., xix, 1861, p. 316 Diesing. Wien. Sitzber., xliii, 1861, p. 280 Schneider. Monogr. d. Nemat., 1866, p. 89 Stossich. Soc. Hist. Nat. Croat., vi, 1891, p. 217 Linstow. Arch. f. Naturg., 1891, p. 292	*Falco subbuteo*, *F. lanarius*, *F. peregrinus*, *Otis brachyotus*, *Strix torquata* (Brazil) *Garrulus glandarius* (Venice)	Thoracic and abdominal cavities and in the muscles
Syn. *F. falconis*	Gmelin. Syst. Nat., p. 3040 Zeder. Naturg. d. Eingw., 1803, p. 38		
F. nodispina	Molin. Wien. Sitzber., xxviii, 1858, p. 402 Diesing. Wien. Sitzber., xlii, 1860, p. 703		
F. quadripens	Molin. Wien. Sitzber., xxviii, 1858, p. 407 Diesing. Wien. Sitzber., xlii, 1860, p. 703		
F. strigis torquatae	Molin. Wien. Sitzber, xxviii, 1858, p. 422		

(*c*) Pisces

F. ochracea. Linstow.	Linstow. Jenaische Zeitsch, xxviii, 1893, p. 339	*Thymallas vulgaris* (Göttingen)	Stomach

VI. Other Forms

(*a*) Mammalia

F. restiformis. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, 1880, p. 130 Railliet. Zool. méd. et agric. Paris, 1893, p. 530	*Homo sapiens*	See chapter ii
F. diacantha. Molin	Molin. Zool. méd. et agric. Paris, 1893, p. 381	*Cercolabes prehensilis*, *Mesomys spinosus* (Brazil)	Abdominal cavity and lungs
F. felis mellivorae. Molin	Molin. Zool. méd. et agric. Paris, 1893, p. 421	*Felis mellivora* (Brazil)	Lungs
F. felis onçae. Molin	Molin. Zool. méd. et agric. Paris, 1893, p. 421	*Felis onça* (Brazil)	Between the muscles
F. filiformis. Molin	Molin. Zool. méd. et agric. Paris, 1893, p. 396 Diesing. Zool. méd. et agric. Paris, xlii, 1860, p. 702	*Anabates rufifrons* (Brazil)	Abdominal cavity
F. striata. Molin Syn. *Solenonema striatum*	Molin. Wien. Sitzber, 1858, p. 388 Diesing. Wien. Sitzber, xlii, 1860, p. 705	*Felis concolor* *F. macroura* (Brazil)	Subcutaneous
F. scapiceps. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, 1886, p. 308	*Lepus sylvaticus* (N. America)	
F. serpicula. Molin	Molin. Proc. Acad. Nat. Sc., Philadelphia, xxviii, 1858, p. 385	*Corallia brevicaudum* *Phyllostoma spiculatum* (Brazil)	Abdominal cavity
Syn. *Solenonema serpiculum*	Diesing. Proc. Acad. Nat. Sc., Philadelphia, xlii, 1860, p. 705		
F. spirocauda. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, 1858, p. 112 Diesing. Wien. Sitzber, xlii, 1860, p. 701 Braun. Arch. d. F. d. Naturg., i, M. 1891, p. 112	*Phoca vitulina* (Pennsylvania, Warnemünde)	Heart
Syn. *F. cordis phocae*	Joly. Compt. rend. Acad. d. sc., xlvi, 1856, p. 403		
F. stigmatura. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, 1886, p. 309		

Name	Literature	Host	Site
F. conica. Molin	Molin. Proc. Acad. Nat. Sc., Philadelphia, xxviii, 1858, p. 412	*Dasyproeta aguti, Cavia acuschy* (Brazil)	Abdominal cavity
Syn. *Dicheilonema conicum*	Diesing. Proc. Acad. Nat. Sc., Philadelphia, xlii, 1860, p. 708		
F. canis brachyuri. Molin	Molin. Proc. Acad. Nat. Sc., Philadelphia, xxviii, 1858, p. 420	*Canis brachyuris* (Brazil)	Under the tracheal epithelium
F. caprae. Linstow	Linstow. Arch. f. Naturg., xlix, 1883, p. 287 Linstow. Vermi. Mosca., 1886, p. 12 Railliet. Zool. medic. et agric. Paris, 1893, p. 531	*Capra hircus* (Turkestan)	Muscles under the tongue
F. laevis. Creplin	Creplin. System. Helm., ii, 1851, p. 265 Molin. Wien. Sitzber, xxviii, 1858, p. 389 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Tarsius spectrum*	Under the skin
F. leonis. Gmelin	Gmelin. Syst. Nat., i, 1788, p. 3040 Rudolphi. Entoz. Synops., 1819, p. 7 Diesing. Syst. Helm., ii, 1851, p. 280 Molin. Wien. Sitzber, xxviii, 1858, p. 421	*Felis leo*	Under the skin
Syn. *Ascaris leonis*	Gmelin. Syst. Nat., i, 1788, p. 3031		
F. leporis. Gmelin	Gmelin. Syst. Nat., i, 1788, p. 3040 Zeder. Naturg. d. Eingw., 1803, p. 38 Rudolphi. Entoz. Synops., 1819, p. 8 Dujardin. Hist. Nat. d. Helm., 1845, p. 48 Diesing. Syst. Helm., ii, 1851, p. 280 Molin. Wien. Sitzber, xxviii, 1858, p. 421	*Lepus timidus*	Thigh and lumbar region
F. bidentata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 401	*Cervus nambi; C. simplicornis; C. rufus* (Brazil)	Abdominal cavity
F. incrassata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 389 Diesing. Wien. Sitzber, xlii, p. 700	*Nasua socialis* *Bradypus tridactytus* (Brazil)	
F. inflexo caudata. Siebold	Siebold. Wiegemann's Arch., 1842, p. 348 Diesing. Syst. Helm., ii, 1851, p. 281 Baird. Catal. of Entoz. London, 1853, p. 7 Molin. Wien. Sitzber, xxviii, 1858, p. 422 Benedin. Bull. Acad. Roy. Bruxelles Sc., tom. xxix, 1870, p. 364	*Phocaena communis*	Encysted in the lungs
F. insignis. Leidy	Leidy. Proc. Acad. Nat. Sc. Philadelphia, 1858, p. 112 Diesing. Wien. Sitzber, xlii, 1860, p. 711	*Procyon lotor*	Encysted under skin of feet
F. intercostalis. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 418	*Chrysothrix sciurea* (Brazil)	Between the intercostal muscles
F. bifida. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 411	*Dactylomys amblyonyx* (Brazil)	Liver
Syn. *Dicheilonema bifidum*	Diesing. Wien. Sitzber, xlii, 1860, p. 707		
F. nodosa. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 380 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Hapale melanura; Callithrix personata*	Beneath the skin
F. pistillaris. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 381 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Sciurus igniventris* (Brazil)	Beneath the skin
F. annulata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 386	*Lagothrix cana.* (Brazil)	
F. anticlava. Molin	Molin. Wien. Sitzber, xxviii, p. 381 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Dasypus sexcintus*	Stomach
F. acuticauda. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 379	*Dasypus loricatus; D. niger* (Brazil)	Under the skin of the neck
F. aequalis. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 383	*Myrmecophaga jubatu* (Brazil)	
Syn. *Solenonema aequale*	Diesing. Wien. Sitzber, xlii, 1860, p. 704		
F. terminalis. Passerini	Passerini. Atti Soc. Ital. d. sc. nat. Milano, xxviii, 1884, p. 42 Parona. Elmintol. italiana. Genova, 1894, p. 241	*Lepus timidus* (Tuscany)	Lungs
F. oculi canini. Gescheidt	Railliet. Zool. med. et agric. Paris, 1893, p. 531	*Canis familiaris*	Vitreous body of eye
Syn. *F. trispinalosa*	Diesing. Syst. Helm., ii, 1851, p. 274 Molin. Wien. Sitzber, xxviii, 1858, p. 402 Davaine. Traité d. Entoz. Paris, 1877, p. 108		
F. vulpis. Rudolphi	Rudolphi. Entoz. Synops, 1819, p. 7 Diesing. Syst. Helm., ii, 1851, p. 280 Molin. Wien. Sitzber, xxviii, 1858, p. 420	*Canis vulpes*	Abdomen
F. vespertilionis. Rudolphi	Rudolphi. Entoz. Synops., 1819, p. 7 Dujardin. Hist. Nat. d. Helm., 1845, p. 47 Diesing. Syst. Helm., ii, 1851, p. 279 Molin. Wien. Sitzber, xxviii, 1858, p. 419	*Vespertilio discolor* *V. bechsteinii*	Abdomen
F. torta. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 390 Diesing. Wien. Sitzber, xlii, 1860, p. 700	*Lagothrix cana* (Brazil)	
F. macropodis gigantis. Webster	Diesing. Syst. Helm., ii, 1851, p. 280 Molin. Wien. Sitzber, xxviii, 1858, p. 422	*Macropus giganteus*	Knee
F. turdi olivascentis. Molin	Molin. Wien. Sitzber, xlii, 1860, p. 423	*Turdus olivascens* (Brazil)	Beneath the nictitating membrane
F. dubia. Stossich			
Syn. *F. verrucosa*	Molin. Wien. Sitzber, xlii, 1860, p. 392 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Falco swainsonii* (Brazil) *Strix suinda*	Between the muscles of the lower jaw
F. papilloso-annulata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 399 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Falco swainsonii* (Brazil)	Orbit

(*b*) Aves

Name	Literature	Host	Site
F. campanulata. Molin	Molin. Wien. Sitzber, xxviv, 1858, p. 392 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Falco magnirostris* (Brazil)	
F. tendo. Nitzsch		*Falco peregrinus*	
F. labiotruncata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 412	*Tinamus adspersus, T. strigulosus, T. variegatus* (Brazil)	Abdominal cavity, and under skin
Syn. *Dicheilonema labiotruncatum*	Diesing. Wien. Sitzber, xlii, 1860, p. 708		
F. quadrilabiata. Molin	Molin. Wien. Sitzber, xlii, 1860, p. 417	*Tinamus rufescens, T. maculosus* (Brazil)	Abdominal cavity, and subcutaneous
Syn. *Tetracheilonema quadrilabiatum*	Diesing. Wien. Sitzber, xlii, 1860, p. 711		
F. tinami variegati. Molin	Molin. Wien. Sitzber, xxviii, 1858, p, 427	*Tinamus variegatus* (Brazil)	Beneath the nictitating membrane
F. subspiralis. Diesing	Diesing. Syst. Helm., ii, 1851, p. 268 Molin. Wien. Sitzber, xxviii, 1858, p. 391 Diesing. Wien. Sitzber, xlii, 1860, p. 700	*Ardea cinerea, A. leucogaster* (Brazil)	Beneath the skin of the feet
Syn. *F. ardeae cinereae*	Rudolphi. Entoz. Synops., 1819, p. 9 Dujardin. Hist. Nat. d. Helm., 1845, p. 56		
F. ardeae. Molin	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 428	*Ardea exilis* (Brazil)	Under the tongue
F. myotherae campanisonae. Molin	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 425	*Formicivora campanisona* (Brazil)	Eye
F. myotherae chrysopygae. Molin	Molin. Hist. Nat. d. Helm., 1858, p. 425	*Formicivora chrysopyga* (Brazil)	Under skin near the eyes
F. myotherae regis. Molin	Molin. Hist. Nat. d. Helm , xxviii, 1858, p. 424	*Formicivora rex* (Brazil)	Kidney
F. myotherae ruficipitis. Molin	Molin. Hist. Nat. d. Helm , xxviii, 1858, p. 424	*Formicivora ruficeps* (Brazil)	Abdominal cavity
F. tridens. Molin	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 393 Diesing. Hist. Nat. d. Helm., xlii, 1860, p. 702	*Lanius collurio; Icterus cristatus; I. haemorrhous; I. icterocephalus; I. chopi; I. sericeus; Cassicus ater; C. viridis*	Abdominal and thoracic cavities
Syn. *F. cassiciatri*	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 423		
F. icteri pyrrhopteri. Molin	Molin. Hist. Nat. d. Helm., xxviii, p. 423	*Icterus pyrrhopterus* (Brazil)	Abdominal and thoracic cavities
F. bipapillosa. Molin	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 399 Diesing. Hist. Nat. d. Helm., xlii, 1860, p. 702	*Strix suinda* (Brazil)	Under the skin of the neck
F. hystrix. Molin	Molin. Hist. Nat. d. Helm., xxviii, 1858, p. 408 Diesing. Hist. Nat. d. Helm., xlii, 1860, p. 703	*Strix flammea* (Brazil)	Abdominal cavity
F. acuta. Diesing	Diesing. Syst. Helm., ii, 1851, p. 277 Molin. Wien. Sitzber, xxviii, 1858, p. 411 Braun. Arch. d. Fr. d. Naturg., i, M., 1891, p. 112	*Podiceps cristatus* (Rostock); *P. cornutus*	Abdominal cavity
Syn. *F. colymbi Dicheilonema acutum*	Rudolphi. Entoz. Synops., 1819, p. 10 Diesing. Wien. Sitzber, xlii, 1860, p. 707		
F. subulata. Deslongchamps	Dujardin. Hist. Nat. d. Helm., 1845, p. 58 Diesing. Syst. Helm., ii, 1851, p. 283 Molin. Wien. Sitzber, xxviii, p. 429	*Podiceps auritus* (Caen)	Abdominal cavity
F. clavato-verrucosa. Molin	Molin. Wien. Sitzber, xxviii, p. 380 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Thamnophilus canadensis* (Brazil)	On the intestine
F. attenuato-verrucosa. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 394 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Thamnophilus canadensis* (Brazil)	Internal body cavity
F. piprae caudatae. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 424	*Pipra caudata* (Brazil)	Abdominal cavity
F. tricoronata. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 400 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Pipra inornata* (Brazil)	Abdominal cavity
F. veneta. Stossich Syn. *F. quadrispina*	Molin. Wien. Sitzber, xxxiii, 1858, p. 301 Molin. Denkschr. Wien. Akad., xix, 1861, p. 318 Diesing. Wien. Sitzber, xliii, 1861, p. 280 Parona. Elmintol. italiana. Genova, p. 243	*Ibis falcinellus* (Padua)	Between the walls of the stomach
F. tantali cayennensis. Molin	Molin. Elmintol. italiana. Genova, p. 435	*Ibis cayennensis* (Brazil)	Stomach wall
F. carduelis. Rudolphi	Rudolphi. Entoz. Synops., 1819, p. 9 Dujardin. Hist. Nat. d. Helm., 1845, p. 54 Diesing. Syst. Helm., ii, 1851, p. 281 Molin. Wien. Sitzber, xxviii, 1858, p. 423	*Fringilla carduelis*	Thigh
F. affinis. Rudolphi	Rudolphi. Entoz. Synops., 1819, pp. 4 and 209 Dujardin. Hist. Nat. d. Helm., 1845, p. 54 Diesing. Syst. Helm., ii, 1851, p. 268 Molin. Wien. Sitzber, xxviii, 1858, p. 396 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Fringilla hispaniolensis* (Spain)	Abdominal cavity
F. dendrocalaptis procurvi. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 425	*Dendrocalaptes procurvus* (Brazil)	Eye
F. quadriverrucosa. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 398 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Dendrocalaptes picus; D. rufirostris* (Brazil)	Abdominal cavity
F. coronata. Rudolphi	Rudolphi. Entoz. Synops., 1819, p. 6 Lamark. Anim. s. Vert., iii, 1840, p. 668 Dujardin. Hist. Nat. d. Helm., 1845, p. 55 Diesing. Syst. Helm., ii, 1851, p. 275 Molin. Wien. Sitzber, xxviii, 1858, p. 408, and xxx, 1858, p. 155 Diesing. Wien. Sitzber, xlii, 1860, p 703; xliii, 1861, p. 280	*Coracias garrula* (Padua, Vienna, Turkestan)	Under the muscles of head—and skin of neck

Name	Literature	Host	Site
F. coronata. Rudolphi—contd.	Linstow. Arch. f. Naturg., xlix, 1883, p. 286 ; Vermi, Mosca, 1886, p. 11		
	Parona. Elmintol italiana. Genova, 1894, p. 242		
Syn. *Ascaris coraciae*	Gmelin. Syst. Nat., p. 3033		
Fusaria coraciae	Zeder. Naturg. d. Eingw., 1803, p. 119		
F. obtusa. Leidy.	Leidy. Proc. Acad. Nat. Sc. Philadelphia, 1886, p. 308	*Junco hyemalis*	
Syn. *F. obtusa*	Leidy. Proc. Acad. Nat. Sc. Philadelphia, 1885, p. 10	*Sturnella magna*	
F. sturni. Rudolphi.	Rudolphi. Entoz. Synops., 1819, p. 9	*Sturnus vulgaris*	Lungs and thoracic cavity
	Dujardin. Hist. Nat. d. Helm., 1845, p. 53		
	Diesing. Syst. Helm , ii, 1851, p. 281		
	Molin. Wien. Sitzber, xxviii, 1858, p. 424		
F. abbreviata. Rudolphi	Rudolphi. Entoz. Synops., 1819, pp. 4 and 210	*Saxicola sp.* (Turkestan) ;	The internal cavities of the body
	Dujardin. Hist. Nat. d. Helm., 1845, p. 52	*Luscinia philomela* ;	
	Diesing. Syst. Helm., ii, 1851, p. 268	*Motacilla melanocephala*	
	Molin. Wien. Sitzber, xxviii, 1858, p. 396	(Brazil) ; *Saxicola oenanthe* ;	
	Linstow. Arch. f. Naturg., xlix, 1883, p. 286	*S. stapazina* ; *Luscinia*	
	Linstow. Vermi. Mosca, 1886, p. 11	*rubecula* ; *Turdus pilaris* ;	
Syn. *F. motacillae*	Rudolphi. Entoz. Synops., 1819, p. 635	*T. viscivorus* ; *Sturnus*	
F. motacillarum	Rudolphi. Entoz. Synops., 1819, p. 9	*pyrrhocephalus* (Brazil) ;	
F. turdorum	Rudolphi. Entoz. Synops, 1819, p. 9	*Tanagra jacapa* (Brazil) ;	
F. philomelae	Diesing. Syst. Helm., ii, 1851, p. 226	*Thryothorus polyglottus* (Brazil) ; *Furnarius rufus* (Brazil) ; *F. leucops* (Brazil)	
F. simplicissima. Molin	Molin. Syst. Helm., xxviii, 1858, p. 372	*Psittacus makaonanna* (Brazil)	Beneath the skin
	Diesing. Syst. Helm., xlii, 1860, p. 701		
F. truncato-caudata. Deslongchamps	Dujardin. Hist. Nat. d. Helm., 1845, p. 56	*Vanellus cristatus* (Caen, Turkestan)	Abdominal cavity
	Diesing. Syst. Helm., ii, 1851, p. 283		
	Molin. Wien. Sitzber, xxviii, 1858, p. 427		
	Linstow. Arch. f. Naturg., 1883, xlix, p. 287		
	Linstow. Vermi. Mosca, 1886, p. 11		
F. bifurca. Molin	Molin. Wien. Sitzber, xviii, 1858, p. 400	*Muscicapa sp.* (Brazil)	Abdomen
F. bilabiata. Diesing	Diesing. Syst. Helm., ii, 1851, p. 277	*Sterna leucopareia*	Abdominal cavity
	Molin. Wien. Sitzber, xxviii, 1858, p. 411		
Syn. *F. sternae*	Rudolphi. Entoz. Synops, 1819, p. 10		
Dicheilonema bilabiatum	Diesing. Wien. Sitzber, xlii, 1860, p. 707		
F. cygni. Rudolphi	Rudolphi. Entoz. Synops., 1819, p. 10	*Cygnus musicus*	Abdominal cavity
	Dujardin. Hist. Nat. d. Helm., 1845, p. 58		
	Diesing. Syst. Helm., ii, 1851, p. 284		
	Molin. Wien. Sitzber, xxviii, 1858, p. 429		
	Railliet. Zool. med. et Agric. Paris, 1893, p. 533		
	Parona. Elmintol. italiana. Genova, 1894, p. 243		
Syn. *Ascaris cygni*	Gmelin. Syst. Nat., p. 3033		
Fusaria cygni	Zeder. Naturg. d. Eingw., 1803, p. 119		
F. armata. Gescheidt	Diesing. Syst. Helm., ii, 1851, p. 275	*Buteo lagopus*	In vitreous humour of the eye
	Molin. Wien. Sitzber, xxviii, 1858, p. 404		
	Diesing. Wien. Sitzber, xlii, 1860, p. 703		
F. anatis. Rudolphi	Rudolphi. Entoz. Synops, 1819, p. 20	*Anas domestica*	The leg
	Dujardin. Hist. Nat. d. Helm., 1845, p. 58		
	Diesing. Syst. Helm., ii, 1851, p. 284		
	Molin. Wien. Sitzber, xxviii, 1858, p. 429		
	Railliet. Zool. med. et agric. Paris, 1893, p. 533		
F. sylviae. Nordmann	Nordmann. Microgr. Beiträge, i, 1832, p. 17	*Sylvia abietina*	Orbit
	Diesing. Syst. Helm., ii, 1851, p. 281		
	Molin. Wien. Sitzber, xxviii, 1858, p. 423		
F. spaerophora. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 401	*Anabates anthoides* ; *Muscicapa lophotes* (Brazil)	Liver
F. spinulosa. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 350	*Glareola austriaca*	Stomach wall
	Diesing. Wien. Sitzber, xlii, 1860, p. 712		
F. trochili amethystini. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 426	*Calliphlox amethystina* (Brazil)	On the stomach
F. lari. Rudolphi	Rudolphi. Entoz. Synops, 1819, pp. 10 and 218	*Larus minutus* (Vienna)	Under the skin of the neck
	Dujardin. Hist. Nat. d. Helm., 1845, p. 58		
	Diesing. Syst. Helm., ii, 1851, p. 283		
	Molin. Wien. Sitzber, xxviii, 1858, p. 429		
F. meropis. M.C.V.	Rudolphi. Entoz. Synops., 1819, p. 9	*Merops apiaster*	Mesentery
	Dujardin. Hist. Nat. d. Helm., 1845, p. 55		
	Diesing. Syst. Helm., ii, 1851, p. 281		
	Molin. Wien. Sitzber, xxviii, 1858, p. 426		
F. aspera. Nitzsch		*Otis brachyotus*	Subcutaneous
F. podoae. Molin	Molin. Wien. Sitzber, xxviii, 1818, p. 428	*Podoa carinanemsis* (Brazil)	Beneath the skin of the neck
F. charadru. M.C.V.	Rudolphi. Entoz. Synops., 1819, p. 10	*Charadrius fluviatilis* (Vienna)	Under the skin of the nose and ear
	Dujardin. Hist. Nat. d. Helm., 1845, p. 56		
	Diesing. Syst. Helm., ii, 1851, p. 283		
	Molin. Wien. Sitzber, xxviii, 1858, p. 427		
F. circumflexa. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 377	*Trogon aurantius* (Brazil)	Abdominal cavity

Name	Literature	Host	Site
F. tringae. M.C.V.	Rudolphi. Entoz. Synops., 1819, p. 10 Diesing. Syst. Helm., 1851, p. 282	*Tringa variabilis*	Beneath the skin
F. serotina. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 374 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Lichenops perspicillata* (Brazil)	Abdominal cavity
F. fusiformis. Molin Syn. *Dicheilonema fusiforme*	Molin. Wien. Sitzber, xxviii, 1858, p. 415 Diesing. Wien. Sitzber, xlii, 1860, p. 709	*Monasa tranquilla* (Brazil)	Thoracic cavity
F. physalura. Bremser	Diesing. Syst. Helm., ii, 1851, p. 256 Molin. Wien. Sitzber, xxviii, 1858, p. 412 Leidy. Proc. Acad. Nat. Sc, Philadelphia, 1885, p. 10	*Alcedo amazona*; *A. torquati*, *A. supercilosa*; *Ceryle alcyon* (Brazil)	Abdominal cavity
Syn. *F. alcedinus* *F. alcedinus superciliosae* *Monopetalonema physalurum*	Rudolphi. Entoz. Synops., 1819, p. 635 Molin. Wien. Sitzber, xxviii, 1858, p. 426 Diesing. Wien. Sitzber, xlii, 1860, p. 710		
F. corvi torquati. Cobbold and Manson		*Corvus torquati*	Right ventricle of heart and pulmonary
F. picae mediae. Cobbold and Manson		*Pica media*	In tubercles on the pulmonary and aortic valves
F. helicina. Molin.	Molin. Wien. Sitzber, xxviii, 1858, p. 391	*Plotus anhinga* (Florida)	Brain
F. hemicyla. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 377 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Pionus menstruus* (Brazil)	Under the skin of the neck
F. bonasiae. Nordmann	Dujardin. Hist. Nat. d. Helm., 1845, p. 56 Diesing. Syst. Helm., ii, 1851, p. 282 Molin. Wien. Sitzber, xxviii, 1856, p. 426	*Tetrao bonasio*	Eye
F. perdicis dentatae. Molin.	Molin. Wien. Sitzber, xxviii, 1858, p. 427	*Perdix dentata* (Brazil)	Abdominal cavity
F. triaenucha. Wright	Wright. Americ. Helminth I, 1879, p. 21	*Botaurus minor* (America)	Proventicule
F. dipetala. Molin Syn. *Dipeta lonema inflexum*	Molin. Wien. Sitzber, xxviii, 1858, p. 373 Diesing. Wien. Sitzber, xlii, 1860, p. 704	*Platyrhynchus petangua* (Brazil)	Abdominal cavity
F. cirrura. Leidy	Leidy. Proc. Acad. Nat. Sc. Philadelph. viii, 1886, p. 309	*Guiscalus major* (Florida)	

(*c*) Reptilia

F. mucronata. Molin	Molin. Wien. Sitzber, xxx, 1858, p. 155 Molin. Denkschr. Wien. Akad., xix, 1861, p. 318		
Syn. *Dipetalonema mucronatum*	Diesing. Wien. Sitzber, xlii, 1860, p. 704, and xliii, 1861, p. 280	*Boa constrictor*	Thoracic cavity
F. bispinosa. Diesing	Diesing. Syst. Helm., ii, 1851, p. 278 Leidy. Proc. Acad. Nat. Sc. Philadelphia, viii, 1856, p. 56 Diesing. Denkschr. Wien. Akad., xiii, 1879, p. 18 Molin. Wien. Sitzber, xxviii, 1858, p. 415	*Boa constrictor*; *Ophis saurocephalus*; *Thamnobius poecitostomo* (Brazil)	Under the skin, in the abdominal cavity, and in the walls of the oesophagus and intestine
Syn. *Dicheilonema bispinosum* *F. boae constrictoris*	Diesing. Wien. Sitzber, xlii, 1860, p. 709 Leidy. Proc. Acad. Nat. Sc. Philadelphia, v, 1851, p. 118		
F. megalochila. Diesing	Diesing. Syst. Helm., ii, 1851, p. 278 Molin. Wien. Sitzber, xxviii, 1858, p. 417	*Coronella austriaca*	Oesophagus
Syn. *F. colubri anstriaci* *Tricheilonema megalochilum*	Rudolphi. Entoz. Synops, 1819, p. 10 Diesing. Wien. Sitzber, xlii, 1860, p. 711		
F. podinemae sciptae. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 430	*Podinema scipta* (Brazil)	In the abdominal fat
F. hajc. Wedl.	Wedl. Wien. Sitzber, xliv, 1861, p. 472	*Naja haje*	All parts external to lungs
F. hebetata. Cobbold		*Cystophora cristata*	Right heart
Filaria bacillaris. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 379 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Caiman niger*; *C. sclerops* (Brazil)	Lungs
F. cloeliae fasciatae. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 431	*Oxyrhopus fasciatis* (Brazil)	Encysted in stomach wall
F. colubri. Box	Box. Hist. Nat. d. vers. Paris, ii, 1802, p. 49 Dujardin. Hist. nat. d. Helm., 1845, p. 58 Diesing. Syst. Helm., ii, 1851, p. 284 Molin. Wien. Sitzber, xxviii, 1858, p. 431	*Coluber sp.* (America)	Intestine
Syn. *F. colubri americani*	Rudolphi. Entoz. Synops., 1819, p. 10		
F. colubri aenei. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 435	*Helicops carinicandus*	Abdominal cavity
F. multipapilla. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 385 Diesing. Wien. Sitzber, xlii, 1860, p. 700	*Thoractis dracaena*; *Iguana tuberculata* (Brazil)	Abdominal cavity
F. calcarata. Molin.	Molin. Wien. Sitzber, xxviii, 1858, p. 378 Diesing. Wien. Sitzber, xlii, 1860, p. 701	*Bothrops jararacca* (Brazil)	Abdominal cavity
F. eunectis scytalis. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 430	*Eunectes scytale* (Brazil)	Lungs
F. solitaria. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien. Sitzber, xxviii, 1858, p. 430 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Emys serrata*; *Chelonura serpentina* (Georgia)	Wall of stomach
F. *cistudinis.* Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien. Sitzber, xxviii, 1858, p. 430	*Cistudo carolina* (America)	Heart

(*d*) Amphibia

Name	Literature	Host	Site
F. rubella. Rudolphi	Rudolphi. Entoz. Synops., 1819, pp. 5 and 212 Dujardin. Hist. Nat. d. Helm., 1845, p. 59 Diesing. Syst. Helm., ii, 1851, p. 269 Molin. Wien. Sitzber, xxviii, 1858, p. 372	*Rana esculenta* (Berlin)	Mesentery; stomach and intestinal walls
Syn. *F. ranae esculentae*	Valentin. Wiegmann's Arch., 1842, p. 312 Diesing. Syst. Helm., ii, 1851, p. 284 Molin. Wien. Sitzber, xxviii, 1858, p. 431		
F. neglecta. Diesing	Diesing. Syst. Helm., ii, 1851, p. 276 Molin. Wien. Sitzber, xxviii, 1858, p. 409 Diesing. Wien. Sitzber, xlii, 1860, p. 703	*Rana esculenta*	Under the skin
Syn. *ranae esculentae*	Rudolphi. Entoz. Synops, 1819, p. 10		
F. nitida. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien. Sitzber, xxviii, 1858, p. 378	*Rana pipiens* (America)	Encysted on the peritoneum and abdominal muscles
F. convoluta. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 390 Diesing. Wien. Sitzber, xlii, 1860, p. 702	*Cystignatus gigas*, *Leptidactylus sibilatrix* (Brazil)	Abdomen
F. amphiumae. Leidy	Leidy. Proc. Acad. Nat. d. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien. Sitzber, xxviii, 1858, p. 431	*Amphiuma meaus* (Philadelphia)	In stomach wall
F. eupemphigis marmorati. Molin	Molin. Wien. Sitzber, xxviii, 1858, p. 431	*Eupemphix marmoratus* (Brazil)	Abdominal cavity

(*e*) Pisces

F. triglae. Bellingham	Bellingham. Ann. of Nat. Hist., xiv, 1844, p. 475 Diesing. Syst. Helm., ii, 1851, p. 286 Molin. Wien. Sitzber, xxviii, 1858, p. 432	*Trigla cuculus* (Ireland)	Peritoneum
F. quadrituberculata. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien, Sitzber, xxviii, 1858, p. 410	*Anguilla vulgaris* (America)	Dorsal muscles
F. mugilis. Bellingham	Bellingham. Ann. of Nat. Hist., xiv, 1844, p. 475 Diesing. Syst. Helm., ii, 1851, p. 286 Molin. Wien. Sitzber, xxviii, 1858, p. 433	*Mugil capito* (Ireland)	Peritoneum
F. ranae. M.C.V.	Molin. Wien. Sitzber, xxviii, 1858, p. 431	*Hypsiboas faber* (Brazil)	Intestine
F. rubra. Leidy	Leidy. Proc. Acad. Nat. Sc., Philadelphia, viii, 1856, p. 56 Molin. Wien. Sitzber, xxviii, 1858, p. 415	*Labrax lineatus* (America)	Peritoneum
Syn. *Dicheilonema rubrum*	Diesing. Wien. Sitzber, xlii, 1860, p. 708		
F. crassiuscula. Nordmann.	Nordmann. Microgr. Beiträge, 1832, p. 20 Dujardin. Hist. Nat. d. Helm., 1845, p. 62 Diesing. Syst. Helm., ii, 1851, p. 286 Molin. Wien. Sitzber, xxviii, 1858, p. 433	*Gadus aeglefinis*	Eye
F. extenuata. Deslongchamps	Dujardin. Hist. Nat. d. Helm., 1845, p. 61 Diesing. Syst. Helm., ii, 1811, p. 285 Molin. Wien. Sitzber, xxviii, 1858, p. 432	*Mullus surmuletus* (Caen)	Abdomen

(*f*) Coelenerata

F. loliginis. Delle Chiaje	Diesing. Syst. Helm., ii, 1851, p. 286 Molin. Wien. Sitzber, xxviii, 1858 p. 434 Parona. Elmintol. italiana. Genova, 1894, p. 244	*Loligo vulgaris* (Naples)	
F. succineae. Siebold	Siebold. Wiegmann's Arch., 1837, p. 255 Diesing. Syst. Helm., ii, 1851, p. 287 Molin. Wien. Sitzber, xxviii, 1858, p. 434	*Succinea amphibia*	Abdomen

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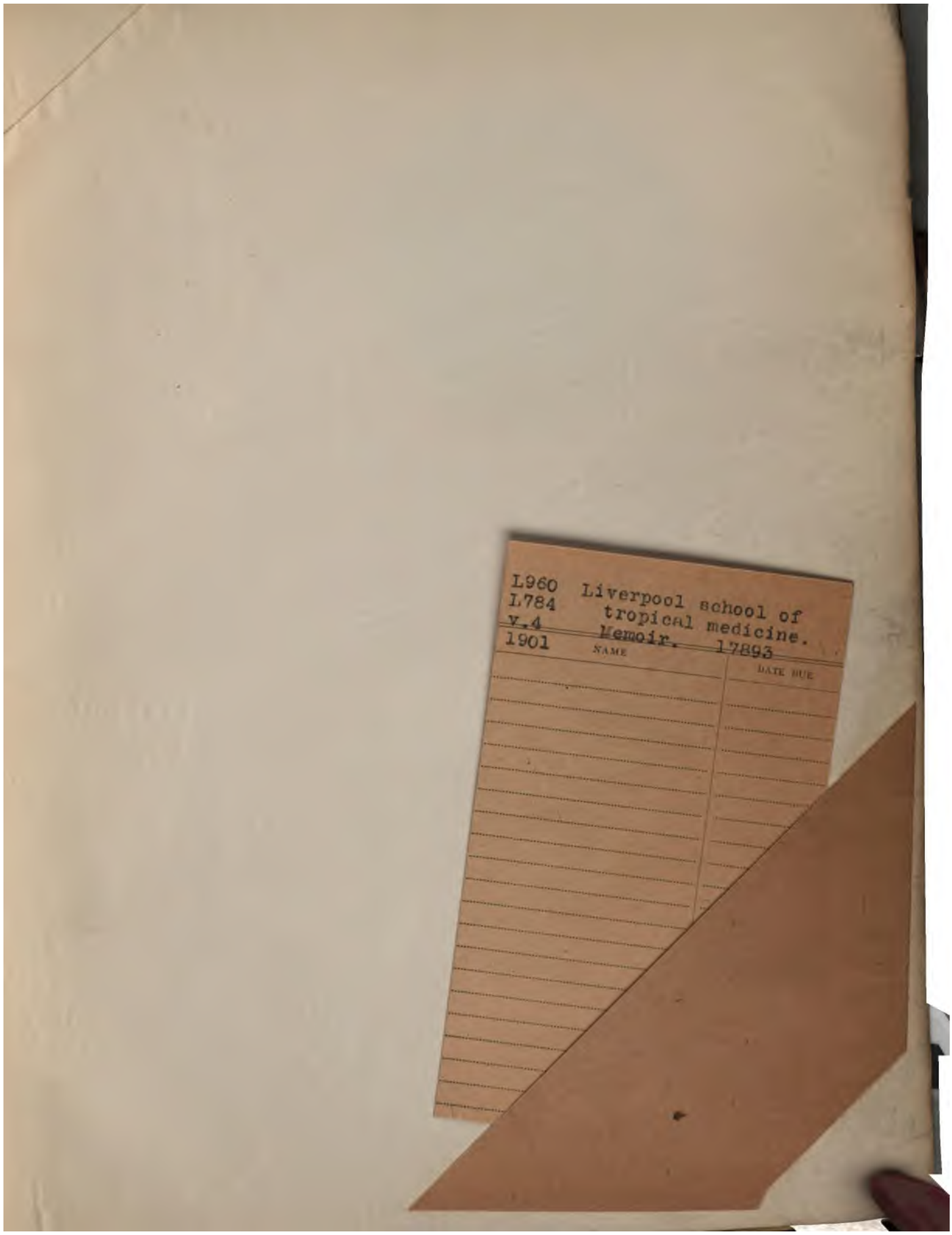
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